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THE PROGRESS OF THE NEW NAVY is shown in a tabulation recently made public by Chief Naval Constructor, Philip Hichborn, U. S. N. At the beginning of 1897, the armed force afloat, neglecting all but the vessels of the new navy constructed since 1883, consisted of 3 first-class battle-ships, 2 second-class battle-ships, 18 cruisers, 7 gunboats, 6 double-turreted coast defense armor-clad vessels, 3 torpedo boats, 2 dispatch boats, and the ram "Katahdin." During the first ten months of 1897 there were added to this force 1 battle-ship, 8 gunboats, and 3 torpedo boats, or 12 new vessels in all. There are now under construction, 5 first-class battle-ships, 1 gunboat, 16 torpedo boats, and 1 submarine torpedo boat. The names of these vessels now under contract, their builders and the state of progress on each, are shown in the following table:

	Name.	Builder and city.	Work complid.
	Battle-ships.		
No. 5.	"Kearsarge"	Newport News, Va.	45%
No. 6.	"Kentucky"	Newport News, Va.	44%
No. 7.	"Illinois"	Newport News, Va.	24%
No. 8.	"Alabama"	Cramp & Sons, Philadelphia	25%
No. 9.	"Wisconsin"	Union Irn Wks., San Francisco	19%
	Gunboat.		
No. 13.	"Princeton"	Dialogue & Son, Camden, N.J. Torpedo Boats.	91%
No. 4.	"Rodgers"	Columbian Irn Wks, Baltimore	90%
No. 5.	"Winslow"	Columbian Irn Wks, Baltimore	90%
No. 8.	"Rowan"	Moran Bros., Seattle, Wash.	83%
No. 9.	"Dahlgren"	Bath (Me.) Iron Works	8%
No. 10.	"T. A. M."	Bath (Me.) Iron Works	8%
No. 11.	"Farragut"	Union Irn Wks, San Francisco	11%
No. 12.	"Davis"	Wolff & Zwicker, Portland, Ore.	58%
No. 13.	"Fox"	Wolff & Zwicker, Portland, Ore.	46%
No. 14.	"Morris"	Hereshoff Mfg. Co., Bristol, R.I.	0%
No. 15.	"Talbot"	Hereshoff Mfg. Co., Bristol, R.I.	48%
No. 16.	"Gwin"	Hereshoff Mfg. Co., Bristol, R.I.	48%
No. 17.	"Mackenzie"	C. Hillman Co., Philadelphia.	60%
No. 18.	"McKee"	Columbian Irn Wks, Baltimore	20%
No. 19.		Harlan & Hollingsworth, Wilmington, Del.	0%
No. 20.		Wolff & Zwicker, Portland, Ore.	0%
No. 21.		Gas Engine & Power Co, N.Y.	0%
	Submarine Torpedo Boat.		
No. 1.	"Plunger"	Columbian Irn Wks, Baltimore	61%

The completion of these vessels will make the total number of vessels in the new navy 77.

THE LARGE FREIGHT STEAMER "PRAETORIA," of the Hamburg-American Line, was launched in England on Oct. 9. This vessel is a sister ship to the "Pennsylvania," which is said to be the largest ocean freight carrier in the world, and is 585 ft. long, 62 ft. beam, and 41 ft. deep, and is registered at 13,500 tons.

STREET PAVING AND CLEANING FOR CHICAGO were discussed recently before a meeting of the Union League Club of that city. Mr. L. E. McGann, Commissioner of Public Works, stated that the present paving includes 63% of cedar block, 25% of granite block and 4 or 5% of asphalt. He favored asphalt for general use, granite block pavement (of better construction than that now used) for streets having the heaviest and roughest traffic, and brick for second-class business streets. He also advocated concrete or flag sidewalks. Mr. J. J. Badenoch, formerly Chief of Police, suggested the employment of the assistance of the police in enforcing cleanliness of the streets and alleys. Under this plan the police officers would make daily reports on sanitary conditions of their posts, noting the number of times per week that the garbage boxes were cleaned, lodging complaints against negligent garbage collecting and street cleaning contractors, and noting the time of sweeping and removing the swept up dirt. He stated that Mayor Swift at the beginning of his term of office abolished the office of sidewalk inspector, and required the Police Department to make daily reports to the Department of Public Works of all defective sidewalks, thus saving to the city the cost of 34 sidewalk inspectors previously employed at an annual expense of $34,000, who could not possibly render a daily report of all defective sidewalks in their territory, and securing from the police without any expense much more accurate and reliable information, as it was made the duty of each patrolman to report the defective sidewalks on his post, and he was held personally responsible for his failure to do so. Maj. J. W. Howard delivered a lengthy address on the relation of clean streets to sanitary conditions, and spoke strongly in favor of non-political control of municipal work. He presented the following table of the cost of street cleaning:

Cities.	Cost—Cleaning and removing garbage.	Per capita—Annual.	Per capita—Weekly.	To be cleaned necessary.	Total miles pavement.
Chicago	$672,000	$0.38	5¼ cts.	525	1,183
New York ..	2,889,000	1.66	3 "	395	499
Boston	396,000	.68	1⅓ "	150	319
Paris	1,400,000	.54	1 "	556	586
Berlin	1,400,000	.82	1 3-5"	270	270
Vienna	850,000	.61	1 1-5"	195	195

This shows that Chicago is appropriating less than any of the cities given and that each person will have to give more than ¾-ct. per week to keep about half of the paved streets at all clean. The other half of the paved streets, principally because of the practically abandoned wood pavement upon them, cannot be cleaned in any admissible sense of the word.

THE FALL OF A THEATER ROOF in Cincinnati, O., on Oct. 15, killed two persons and injured a score of others, some very seriously. The accident occurred at Robinson's Opera House, and seems to have been caused by the failure of the wooden trusses supporting the domed ceiling over the auditorium, which precipitated the ceiling and supporting timbers onto the audience below. Several explanations have been given to account for the failure of the timber trusses, but as the timbers were found to be rotten and the joints shrunk apart, the explanation is evidently not very far to seek. It is said that the trusses had been in place since 1870, and had not been inspected or repaired in that time, so far as is known.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head-end collision on the Canadian Pacific Ry., between Sittsville and Hazeldean, Ont., on Oct. 14, which caused the death of four and the injury of three persons. The collision occurred between the Toronto Express and a freight train. The engine of the express train left the track and its tender telescoped into the first baggage car. Both the engine and cars of the freight train were derailed and heaped up alongside the track, which was badly torn up. The press dispatch gives conflicting statements as to the cause of the accident, but the most reasonable one seems to be that the freight train had got stalled on the grade approaching Sittsville and had left part of its train behind. After bringing the first section into the station the engine had gone back for the second section, and was returning toward the station when the collision occurred. In going back for the second section the trainmen had either failed to notify the station master to hold the express train or else the station master had neglected or misunderstood the order. The killed and injured were all employees of the railway.

A BOILER EXPLOSION at Rockdale, Tex., on Oct. 9, completely wrecked the water and electric light plant and killed the fireman and seriously injured two other persons. The boiler was 75 HP, and it is stated that an 8-ft. section of the front end was blown three blocks. The accident leaves the town entirely without a water supply or light, and it is estimated that it will be 30 days before the plant can be got in running order again.

A FIRE DESTROYED WINDSOR, NOVA SCOTIA, almost completely, on Oct. 17. Of the 3,500 inhabitants of the town the press dispatches state that nearly 3,000 have been left homeless. The origin of the fire is unknown. The total loss is estimated roughly at $3,000,000.

THE BURSTING OF A WATER TANK AT RITZville, Wash., is reported as having occurred on Oct. 6. According to "The Manual of American Water-Works" for 1897 the tank was of wood, 20 ft. in diameter and 30 ft. high, and rested on a timber trestle 40 ft. high. The water-works at Ritzville were built in 1894.

MUNICIPAL INVESTIGATION OF STREET RAILways is to be instituted in Chicago, and the council has unanimously voted the passage of an ordinance for this investigation. The following are the principal matters to be reported on:

What lines of street railway are now operated by each company, and under what franchises, and specifying the dates when said franchises expire respectively.

An inventory of all the tangible property of each of the street railway companies; its original cost and present cash value.

The gross receipts, operating expenses, fixed charges, and the amount and rate of dividends paid by each company during each year of its existence.

The amount of capital stock of each company and the average market value thereof during 1896 and prior years so far as may be deemed material; also the date, amount and purpose of each issue of said stock, and the consideration for which it was disposed of.

The amount of bonded indebtedness at the present time, and the annual interest thereon, and for what purpose such bonded indebtedness was created.

The amounts paid into the public treasury by each company for taxes, licenses or other public purposes during each year of its existence.

The number of passengers carried and the number of transfers issued by each company in 1896, and in previous years so far as may be deemed material.

The amount and value of all donations, bonuses or other payments of any kind received by each company at any time for the extension or building of any lines of street railway.

The amount of capital lost by any company at any time by reason of a change of motive power.

The scale of wages paid employés by each company, and the conditions of employment.

The committee is authorized to employ such expert and clerical assistance as may be necessary and as may be approved by the mayor, such assistants to receive such compensation as the mayor shall approve and as shall be duly authorized.

THE CHICAGO STREET RAILWAYS are receiving a good deal of attention from the city authorities just now. Ordinances have recently been passed requiring the cars to be fitted with fenders, and instituting a committee to investigate the franchise and the financial conditions of the roads; while two others under consideration require the cars to be fitted with vestibules or other protection for the motormen during the winter, and requiring the companies to use the same paving between the track as is used on the rest of the street. The corporation counsel has also rendered an opinion to the effect that the street railways have no right, under their franchises, to operate mail cars on their lines, and that the authority granted by the United States government is not sufficient to give them such a right. The post office authorities at Washington, however, say that such an opinion is absurd, as congress, by statute, gave the post office department authority to contract with street railway companies for carrying the mails. Every car carrying mail under such contract, it is claimed, has the same rights as a steam train that carries the mail, and any persons interfering with the mails, whether city officials or employés who are on strike, are liable to punishment.

THE CONNECTICUT STATE SEWAGE DISPOSAL Commission has organized by electing Prof. Edw. H. Jenkins, of New Haven, as chairman and Robt. A. Cairnes, City Engineer of Waterbury, as secretary. The commission has made the following provisional outline of its proposed work: A study of the past and present condition of sewage disposal with special reference to English practice; review of litigation over stream pollution in Connecticut, descriptions of purification plants already built in the state, and discussion of the situation in certain tidewater and inland cities, and groups of cities in certain valleys; suggestions as to state legislation, such as refusal to authorize cities to issue sewer bonds until plans for sewage disposal had been approved by some competent state body.

CIVIL SERVICE EXAMINATIONS for positions in the Department of Public Works of New York, N. Y., are announced as follows: Mason building inspector, Oct. 21 and 22; inspectors of regulating, grading and paving, Oct. 25. Candidates must be over 18 years of age and citizens of the United States. For the position of mason building inspector there is no residential requirement, but for inspector of regulating, grading and paving, candidates must be residents of New York state. The candidates for mason building inspector must have had at least ten years' practical experience. The secretary of the Civil Service Commission is S. Wm. Briscoe, New Criminal Court Building, New York, N. Y.

THE HOLMAN FRICTION GEARED LOCOMOTIVE, to which we have referred several times in past issues, is reported to have reached a speed of 104 miles per hour in a recent trial run on the South Jersey R. R. The entire run of 56.1 miles was, it is stated, made in 55 minutes. This speed was attained, it is proper to add, with a train of only two cars.

REPLACING BRIDGE NO. 69, PENNSYLVANIA R. R., NEAR GIRARD AVE., PHILADELPHIA.

By Jos. Wood Wagner,* Jun. Am. Soc. C. E.

The replacing of the old metal span of the bridge carrying the New York Division of the Pennsylvania R. R. over the Schuylkill River, within the limits of the city of Philadelphia, has been the occasion of no little interest to all traveling over this portion of the road. The conditions under which this work has been carried on have combined to excite a feeling of admiration and wonder from what may be termed a layman's standpoint. Although the engineering features and the obstacles to be overcome are in a measure identical with several undertakings of a similar nature, it is hoped that this special case will develop enough originality to merit a careful description.

The New York Division of the Pennsylvania R. R., known as the Connecting Ry., crosses the Schuylkill River at a point immediately above the Girard Avenue bridge, the two tracks being carried by a bridge made up of masonry arches with a deck span of metal over the main river channel. This span was built by the railroad company in or about the year 1865, and, according to the practice at that time, was a composite construction of wrought and cast iron. The two pin-connected trusses, 236 ft. 3 ins. c. to c. of end pins, were of the double intersection, or Whipple type, with all

FIG. 1.—WHIPPLE TRUSS BRIDGE ON THE PENNSYLVANIA R. R. OVER THE SCHUYLKILL RIVER NEAR GIRARD AVE., PHILADELPHIA, PA. BUILT 1865.

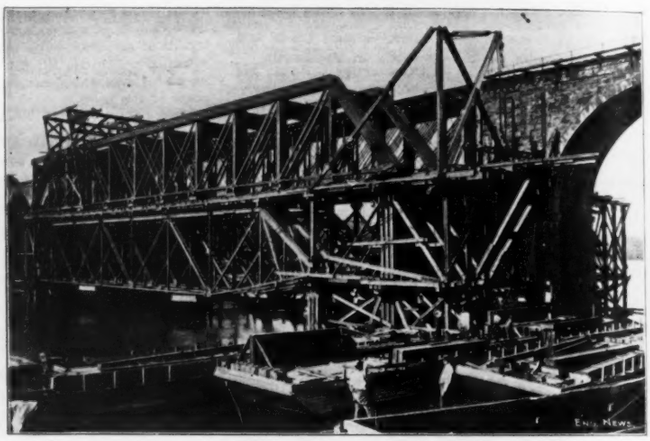


FIG. 2.—REPLACING WHIPPLE TRUSS BRIDGE ON PENNSYLVANIA R. R. AT GIRARD AVE. WITH PRATT TRUSS, OCT. 17, 1897.
View from South side looking West, showing new span nearly erected, with temporary erection span beneath and old bridge still in position.
Actual time occupied in changing spans, 2 minutes, 30 seconds.
Actual time between last train over old span and first train over new span, 14 minutes.)

connections and vertical end posts of cast-iron, and the chords, diagonals and intermediate posts of wrought iron, the whole being braced by adjustable rods. The web members and general design of this span are very clearly shown by the accompanying photograph.

Owing to the somewhat antiquated design, coupled with the great growth in traffic and the increased weight of locomotives and rolling stock, the company deemed it expedient to remove this old span and replace it with a new one of modern design and construction. The preliminary work on the construction was begun in August, 1897, and particular attention is called to the fact that in consideration of the methods pursued, as will be developed later, the question of time was of but little importance and the entire work was prosecuted at the convenience of the company.

The elevation of the rail on the river span is at a height of some 87 ft. above the surface of the water, and as the bottom of the river is in addition of an unreliable nature, it was not feasible to divert the travel from the span to a timber trestle turnout. These conditions led to the adoption of the method used, the principle of which is of a very simple nature, consisting in the bodily removal of the old and the substitution of the new span, both spans being moved simultaneously in a horizontal plane transverse to the line of the tracks, during an interval between trains, thereby not impeding or interfering with traffic on the road.

The development of this principle so that it may be fully understood will now be taken up in detail. The center line of the railroad runs approximately from east to west, crossing the Schuylkill River at a right angle, hence the piers at either end of the truss span are parallel with the river, the ends of the piers facing north and south. Work was commenced by driving piles at either end and against the inside face of each pier, forming an extension thereto some 40 ft. long in a line transverse to the longitudinal center line of the span. These piles formed the foundation of timber falseworks which were then constructed up to a height of the same elevation as the bridge seat of the existing span. The timber extension to the bridge seat and pier formed a continuous pier of increased width, consisting of masonry and timber in the center and timber on either side. The falseworks some 8 ft. above the water line were further extended in width to make a platform to serve as a seat for a temporary erection span which was used instead of falsework for the erection of the new span. This temporary erection span was then placed in position by the use of barges and was so arranged on rails under the shoes as to be capable of motion up or down stream for the whole length of the transverse falseworks. The lower chord of this span being but a few feet above the water completely obstructed the main channel, but ample waterway was afforded through the arch on the west side.

The old span was now jacked up and the roadbed on the masonry approaches was raised to permit of this being done without in any way impeding traffic. The pedestals of the existing span being thus raised above the masonry permitted the introduction under them of a system of bed plates and rollers. The lower bed plate directly upon the bridge seat was composed of six 100-lb. T-rails, with the heads up, the rails running the full length of the pier and the timber falseworks. Upon the bed plate thus formed a train or nest of continuous rollers was placed; 150 rollers, 2½ ins. in diameter, were used at each pier, all the rollers in the nest being provided with shoulders and connected by a side strap. On top of the roller nest a second set of bed plates of six 100-lb. T-rails were placed with heads down, and upon these the pedestals of the old truss were allowed to rest, the jacks removed and the span anchored to prevent premature motion. The six rails forming each bed plate were rigidly bolted together, uniting them into one.

During this operation the new span was being erected on the south side of the old span, and upon the temporary erection span, and when sufficient connections had been made for swinging the span was dropped and rested on the continuation of the same bed plates and roller nest upon which the old span had already been placed. Field riveting on the new span was now pushed to completion, the laterals and sway bracing were put in place, and the ties, rails and guard rails were all laid in readiness for travel. Nothing now remained to be done but to move the old span out and the new one into its place, and in order to unite the two spans rigidly they were securely connected by timber cradles near their ends and thoroughly clamped together with rods.

In erecting the falseworks and the new span, hoisting engines were used, and two of these were placed on the transverse falseworks, one at each pier on the north side and firmly braced. The tractive power to move the spans was supplied by these engines and two auxiliary hoisting engines on barges, 2½-in. manilla ropes being used to connect with their spools and to the end shoes and temporary bracing of both the new and the old spans, passing through an elaborate system of blocks and pulling on substantial anchorages as fulcrums. Four blocks of four sheaves or eight strands of rope each were used, making in all 32 lines; each engine on the falseworks was provided with four spools, two spools and two blocks serving each end of both the old and new spans and all working in unison. The anchorages consisted of heavily braced clusters of timbers on the extreme northern end of the falseworks, and were well braced against the masonry pier and to the timber work. To provide against a sudden movement and to act as a check a block and tackle was rigged on the south side at each end of the span and tended by hand around a snubbing post.

By the afternoon of Saturday, Oct. 16, everything was in readiness for shifting, and the time was set for the afternoon of the following day, Sunday, Oct. 17, the interval between the 2.56 and 3.41 trains being considered sufficient for the purpose. Immediately after the 2.56 train had crossed the old span, the workmen disconnected the rails of the existing tracks, and at 2.58½ the engines were started and the bridge commenced to move. At 3.01 the new span was in position, having been moved a distance of 27 ft., and the connection of the new rails was pushed as rapidly as possible, so that at 3.10 a locomotive drawing a special car crossed over the new bridge. It is of interest to note that the spans were moved in the face of a very strong opposing wind. In moving these spans a very simple and effective device was employed to indicate the relative motions of either of the

* Bureau of Surveys, Room 418 City Hall, Philadelphia, Pa.

two ends of the spans, consisting of two weights suspended from one of the old trusses, the lines running through blocks on the top chord, thence to blocks on either pier, and finally connecting with the end post at each end of the truss. The weights being adjusted in their initial position at exactly the same level, and side by side, immediately indicated by their relative vertical motion any unequal movement in the spans.

The above figures giving the time during the operation are a sufficient indication of the nicety with which the transfer was made and no words in praise thereof can serve to further commend it.

The operation of moving, with the exception of the removal of the rollers and bed-plates used in shifting, the introduction of the bolsters and rollers of the new span, the readjustment of the road-bed and tracks on the approaches to their original elevations, and the painting of the steel work, completed the permanent work. All the above-mentioned items were proceeded with in the order named. The old span after removal occupied a position on the north, or upstream, side of the new work, its ends supported by the transverse falseworks, and the work of tearing down this structure is now in progress. This work is greatly facilitated by the temporary erection span, which, as previously mentioned, was carried on rails providing for movement upstream, and is being used as a falsework for the old span.

The general arrangement of the improvement was conceived and carried out by the Pennsylvania Railroad officials, as well as the design of the new span, and the whole work was executed by their employees. The new span was constructed and erected by the Edge Moor Bridge Works, of Wilmington, Del., who were also the contractors for the removal and disposition of the old bridge.

The new deck span is of the most modern and substantial design and construction, consisting of two deck Pratt trusses, 19 ft. c. to c., of 11 panels of 21 ft. 5 ins. length by 25 ft. 9 ins. in depth, making the length c. to c. of end pins 235 ft. 7 ins. The total weight of the metal for this span was 570 tons, and this in addition to the weight of the old span, including rails, ties and guards, made an aggregate weight to be moved of about 1,400 tons.

Grateful acknowledgments are due to the Pennsylvania Railroad Company for permission to use this piece of work as a subject for this paper, and for information in regard thereto. It is also a great pleasure to accord to the Edge Moor Bridge Works the credit for the opportunity afforded by their uniform courtesy for the accumulation of much of the data contained herein.

CALCULATION OF SINKING FUND.*

By Peter Mogensen.†

When an engineering structure is planned, the engineer is usually required to estimate the cost of its construction, operation and maintenance.

The annual cost of a structure, plant, or machine, may be divided as follows:

Fixed Charges.—(a) Interest on capital invested. (b) Rent, taxes, insurance, etc.

Operating Expenses.—(a) Wages. (b) Material. (c) Fuel, lubricants, minor repairs, etc.

Maintenance.—(a) Repairs, etc. (b) Sinking fund.

The nature of the several parts of the annual cost is indicated with sufficient clearness by their names, except perhaps the last—maintenance. To properly maintain a plant or structure it must be repaired when necessary. Besides these repairs, a sinking fund must be provided equal to its depreciation in value, to meet the expenses of its reconstruction when worn out or when it has become antiquated and inefficient, or to refund the capital invested in its erection. The annual instalment to be set apart for this purpose will be the sum of the partial instalments required to replace the various parts of the structure under consideration, and the amount will depend upon the length of service of the parts and upon their value when new and when discarded. It is for the determination of these instalments that the adjoined table may be made useful. The conditions under which the sinking fund is accumulated are stated in the explanation of the formula employed in the computation of the table.

ANNUAL PAYMENTS TO A SINKING FUND NECESSARY TO ACCUMULATE $1 AT THE END OF A GIVEN NUMBER OF YEARS.

Int. per ann.	1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	9 %	10 %
r	1.005	1.010	1.015	1.020	1.025	1.030	1.035	1.040	1.045	1.050
n										
2	0.4975	0.4951	0.4923	0.4903	0.4877	0.4853	0.4829	0.4803	0.4781	0.4756
3	0.3298	0.3268	0.3235	0.3199	0.3170	0.3138	0.3106	0.3076	0.3044	0.3014
4	0.2463	0.2425	0.2389	0.2353	0.2318	0.2283	0.2248	0.2214	0.2180	0.2147
5	0.1963	0.1916	0.1881	0.1845	0.1807	0.1771	0.1734	0.1699	0.1664	0.1630
6	0.1625	0.1585	0.1845	0.1506	0.1468	0.1431	0.1394	0.1358	0.1322	0.1288
7	0.1387	0.1345	0.1304	0.1265	0.1228	0.1188	0.1151	0.1115	0.1080	0.1046
8	0.1206	0.1165	0.1124	0.1084	0.1045	0.1007	0.0970	0.0935	0.0900	0.0867
9	0.1061	0.1025	0.0983	0.0943	0.0904	0.0867	0.0831	0.0795	0.0761	0.0729
10	0.0953	0.0913	0.0871	0.0832	0.0793	0.0755	0.0719	0.0685	0.0652	0.0620
12	0.0788	0.0745	0.0704	0.0664	0.0626	0.0590	0.0555	0.0522	0.0491	0.0461
15	0.0629	0.0577	0.0537	0.0498	0.0462	0.0427	0.0394	0.0363	0.0335	0.0308
20	0.0453	0.0411	0.0371	0.0334	0.0300	0.0269	0.0241	0.0215	0.0191	0.0170
25	0.0353	0.0311	0.0273	0.0239	0.0208	0.0179	0.0155	0.0133	0.0114	0.0098
30	0.0287	0.0246	0.0209	0.0177	0.0149	0.0124	0.0104	0.0086	0.0071	0.0058
35	0.0239	0.0199	0.0165	0.0135	0.0109	0.0087	0.0070	0.0056	0.0044	0.0035
40	0.0204	0.0165	0.0133	0.0104	0.0083	0.0062	0.0048	0.0037	0.0028	0.0021
45	0.0177	0.0139	0.0107	0.0082	0.0062	0.0046	0.0034	0.0025	0.0018	0.0013
50	0.0154	0.0118	0.0088	0.0064	0.0047	0.0032	0.0024	0.0016	0.0011	0.0008
60	0.0122	0.0087	0.0060	0.0041	0.0028	0.0018	0.0012	0.0007	0.0005	0.0003
70	0.0099	0.0065	0.0043	0.0028	0.0017	0.0009	0.0006	0.0003	0.0002	0.0001
80	0.0082	0.0051	0.0031	0.0018	0.0010	0.0005	0.0003	0.0001	0.0001	0.0000
100	0.0059	0.0032	0.0016	0.0008	0.0004	0.0002	0.0001	0.0000	0.0000	0.0000

To illustrate, let it be required to determine the yearly instalment for the sinking fund of a manufacturing plant, under the following conditions:

Buildings and Fixtures.—Value when new, $25,000. Period of service, 25 years. Value after above period, nothing. (It is assumed that the cost of removal is equal to the value of old material.)

Machinery.—Value when new, $15,000. Period of service, 15 years. Value when discarded, $3,000.

Boilers.—Value when new, $5,000. Period of service, 10 years. Value when discarded, $500.

The sinking fund is invested to bear an interest of 5% per annum.

The partial sinking funds are as follows: (1) Buildings and fixtures, $20,000, maturing in 25 years. (2) Machinery ($15,000 — $3,000), $12,000, maturing in 15 years. (3) Boilers, ($5,000 — $500), $4,500, maturing in 10 years.

To find the annual instalment for (1) we look in the table for the quantity corresponding to an interest of 5% and n = 25 years. This is seen to be 0.0208. Multiplying this quantity by the capital, C, the product, $20,000 × 0.0208 = $416.00, is the amount required. In the same manner the annual instalment for (2) is: $12,000 × 0.0462 = $554.40; and for (3), $4,500 × 0.0793 = $356.85. The total annual instalment will therefore be, $416.00 + $554.40 + $356.85 = $1,327.25.

This sum then, set apart each year and invested to bear compound interest of 5% per annum will provide for the ordinary depreciation of the plant.

If the interest, or the number of years, or both, should be intermediates of those given in the table, the corresponding value of $\frac{A}{C}$ can be readily found by interpolation.

When a value of $\frac{A}{C}$ is multiplied by 100 (the decimal point moved two places to the right) the per cent. of the capital is given which, when yearly invested at the rate of interest indicated at the head of the corresponding column will become equal to the capital in the number of years shown under n in the same row as the quantity considered. For example, engineers sometimes assume the yearly depreciation of an engine and a boiler to be 4 to 8% of their respective costs. If an amount equal to this depreciation is placed at 5% interest, and we examine the values $\frac{A}{C}$ (multiplied by 100) in the column under 5% interest, we find that 4% and 8% of the costs imply "lives" of about 17 years and 10 years for engine and boiler respectively.

The table can be used in various ways. It will be seen from the formula that it is adapted for computations involving annuities.

Calculation of Sinking Fund.

Formula:— $\frac{A}{C} = \frac{r^s - 1}{r^{sn} - 1}$, when interest is added half-yearly. Where A = annual instalment, the first payable one year after investment, and the last one at the end of n years; C = capital invested; r = one dollar with one-half year's interest added; n = number of years from investment to maturity of sinking fund, when the latter is equal to the capital invested.

$\frac{A}{C}$ = a fraction which will amount to unity in n years.

This fraction, or its equivalent $\frac{r^s - 1}{r^{sn} - 1}$, multiplied by C (the capital) will thus give the annual instalment.

*From an article in the "Technograph," No. 11, published by the Engineering Societies of the University of Illinois.

† Supt. Dredging, Miss. River Commission.

EFFECT OF FOREST DENUDATION ON WATER COURSES AND WATER SUPPLY.*

By Dan. W. Baird.†

To carry out its intents and purposes, the American Forestry Association has not only a theory, but many conditions, to confront. The theory is that every one who owns land has a right to dispose of the natural growth on it at any time and in any manner desirable, provided that navigable streams shall not be obstructed. This theory is good in all law courts. About 75% of all the timber lands in the United States are under private ownership. Neither the federal nor the state governments have any control over the forests on private lands. What can this association do to conserve and preserve existing forests and to encourage tree planting? That is the problem now confronting this association, and as a partial answer this paper is written.

There are only two ways to force people to do their duty. One is through promise of reward, and the other is through fear of punishment. So the American Forestry Association, in order to make its work effective, must appeal to the hopes or the fears of the landowners or farmers. It is of no use to tell them of the rewards or profits they might derive from the planting of trees, although it can be proved that tree plantations, properly managed will pay an annual profit of 2%, and are as safe investments as government bonds. The average land owner is unwilling to wait. He wants a crop to mature every year. He cuts and burns timber in order to open up new grounds for farm purposes.

What are we to do with these landowners in order to induce them to preserve the young forest growth and to plant forest trees? The hope of reward, as shown, is too remote to act as an incentive to tree planting or to any painstaking efforts to conserve or preserve whatever may be left of our natural forest growth. Evidently then we must appeal to the fears of these people.

The facts within the recollection of every citizen of the central south over threescore years of age, who has any common sense and who made anything like accurate observations, is enough to scare any one who is dependent upon nature for a water supply. In middle Tennessee 50 years ago there were "lasting" springs on every farm. Since the timber has been cut off many of the "lasting" springs have become "wet weather" springs. What were considered well-watered farms now depend upon deep-bored wells for stock water. I speak from my own personal knowledge, and will say that the water level of this country has fallen many feet below what it was before the trees were destroyed. Fifty years ago, when wells were dug with hand tools, the experts that we called "water witches" located subterranean streams never more than 35 ft. below the surface of the land. Since steam well-boring machinery has come into general use the forked witch hazel switches "work" for a depth rarely less than 60 ft., and generally over 100 ft.

There is another fact that no one disputes. Forest growths, if they do not increase the rainfall, certainly serve to retain that which does fall, and thus feed the springs and maintain a better volume of water in the brooks, creeks, and rivers for a greater period of each year. Flowing through the city of Nashville is the Cumberland river, and according to an official report made to Congress some forty years ago the river "is navigable for a greater length in miles, according to its channel capacity, than any other river in the United States." Forty-five years ago big side-wheel steamboats delivered at our wharves sugar, rice, and other products from New Orleans; machinery, iron, etc., from Pittsburg and other Ohio and Mississippi river points. There has not been a New Orleans or a Pittsburg steamboat here for years. The United States Government has now a large force at work building locks and dams to restore the navigable capacity of the river. To-day, perhaps, one can, from the State Capitol, see half-grown boys wading the river. The records of the Weather Service show greater and more destructive floods than formerly. Then here are two facts that cannot be disproved. The timber has been largely cut from the watershed of the upper Cumberland; disastrous floods in the river are of more frequent occurrence, and the volume of water in its channel during periods of drought is far smaller than forty years ago. These facts cannot be a mere coincidence.

It would seem nothing but right that the class of people who cut off the primeval forest growth should do the reforesting. It is a mistake to suppose that the lumbermen are wholly responsible for the denudation of the forest lands of the hardwood section of the central south. The farmers have been cutting down and burning timber for more than a hundred years. The lumber trade of this section scracely dates back thirty years. The lumbermen, as a rule, cut only mature trees; the farmers cut everything, and burn the stumps.

Speaking for this section of the country, my suggestion to the American Forestry Association is to try to reach the farmer—the small landowner, as well as the large one—to impress upon him the duty and the necessity of taking

*Abstract of a paper presented at the annual convention of the American Foresty Association, at Nashville, Tenn., Sept. 22, 1897.

†Of the "Southern Lumberman," Nashville, Tenn.

care of the young forest growth, to plant tree seeds and set out young plants on every available spot of ground not needed for cultivation in farm crops. I would suggest the circulation of short, practical articles on the management of young forest growth and tree planting. A very erroneous impression prevails as to the cost of tree planting and the length of time required to produce merchantable timber. Of the nut-bearing trees common to this latitude it is only necessary to bury the mature nuts a few inches in the ground, keep hogs and cattle away from them a few years, and nature will do the rest. Five years will suffice to produce a profitable crop of hickory hoop poles, and the closer the crop of proper size is cut at the proper season the larger the next year's crop will be. Walnut trees suitable for newels, balusters, panel rails, and all kinds of built up work, can be grown within thirty years.

But, in addressing the farmers on this subject, I would appeal to their fears instead of their hopes. When a field has been robbed of its fertility by careless cropping to the extent that it is no longer profitable to cultivate, it should be planted in some kind of tree growth, or it will wash into gullies beyond the hope of redemption during two generations, and become practically an encumbrance to its inheritors instead of a means of support.

FIG. 1.—CROSS-SECTION OF STEEL RAIL HIGHWAY, DESIGNED BY THE OFFICE OF ROAD INQUIRY, U. S. DEPARTMENT OF AGRICULTURE.

THE HIGHEST KITE FLYING RECORD is said to have been exceeded by nearly 1,500 ft. in experiments made at Blue Hill Observatory, Mass., on Oct. 9. A kite with an instrument attached for recording pressures, temperature and humidity, reached a height of 10,900 ft. above the hill top, or 11,500 ft. above the sea level. The highest previous record, which was made at the same place on Sept. 19, was 10,016 ft. (Eng. News, Sept. 23, 1897). The height reached in the last experiment it will be seen is only 60 ft. short of two miles above the sea level.

STEEL RAIL HIGHWAY PROPOSED BY THE U. S. DEPARTMENT OF AGRICULTURE.

Complete designs for wagon roads, with steel trackways, have been prepared by Gen. Roy Stone, Director Office of Road Inquiry, U. S. Department of Agriculture. As many of our readers know, the Agricultural Department has given much attention to the subject of good roads and has organized the office of Road Inquiry to foster highway improvement and experiment with different systems of country road construction. Through the efforts of this office a model macadam road has been built at New Brunswick, N. J. (Eng. News, July 15), and a combination macadam and dirt road, 7,000 ft. long, at Geneva, N. Y. The road at Geneva, N. Y., has a center of macadam, 8 ft. wide, with rolled dirt roadways on each side. These samples of road construction are designed to be object lessons in the economy of good material and construction for country roads.

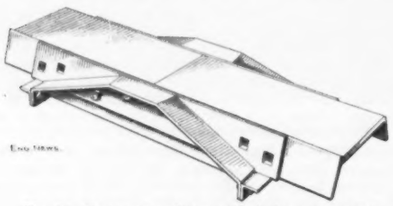


Fig. 2.—Perspective View of Rail Joint for Steel Rail Highway.

The possible advantages of combining a steel trackway for wagons, with the broken stone center, has led the Office of Road Inquiry to investigate the subject with the idea of building an experimental road of this kind. This study has resulted in the design of the steel rail highway which is illustrated in the accompanying cuts. Fig. 1 is a cross-section of the completed road, showing the arrangement of the steel rails and stone filling, and the nature of the drainage system. Fig. 2 is a perspective view of the rail joints, and Fig. 3 is a transverse section of the same joint. It is first proposed to lay 200 ft. of this steel track on the experimental road at Geneva, N. Y.

As will be seen from the illustrations the general idea is to lay two parallel lines of steel rails, supported by a broken stone filling. These rails have an inverted trough section, the top of which forms the track for the wheel, and is 8 ins. wide, with a slightly raised bend on the inside edge to guide the wheel. The thickness of the top of the section which forms the track is about 7-16 in., and the total weight of the steel and connections is about 100 tons per mile of single track. The rails will be connected transversely at intervals to prevent spreading, but there will be no cross ties, the broken stone ballast alone supporting the rail.

The construction at the joints is clearly shown by Figs. 2 and 3. An inverted trough, Section A, forms the basis of the joint support. Over this trough are slipped the two ends of the track rails, B B, which meet in a butt-joint at the center. To each side of the track rails are attached the remounting devices, C C, connected at the ends by the transverse angles, D D. These three principal parts which make up the joint are firmly bolted together, as shown by the drawings. The object of the remounting device is, of course, to enable heavy wagons, which have left the rails, to be easily returned to the track by mounting the inclined shoulder at the rail joints.

Arrangements have been made with the Cambria Iron Co., of Johnstown, Pa., to roll these track rails, the arrangement to go into effect as soon as definite orders for an aggregate of one mile of road are obtained. It is estimated that the cost of rails and joints for one mile of road will be $3,500. As indicating the possible utility of steel rail highways, Mr. Stone has obtained information regarding two previous experiments with steel rails on wagon roads, and has furnished us copies of the letters from the builders, which describe the construction and operation. The first letter is from Mr. F. Melber, engineer and contractor, Standard Building, Pittsburg, Pa., and is, in substance, as follows:

My road has been in position for about a month, and, among other interesting things, I watched the temperature of the steel when exposed to the hot afternoon sun. Every steel worker knows that steel bars lying in the yard of a bridge works, for instance, will get so warm in a few minutes that the men cannot hold them in their hands. I find that my steel stringers remain cooler than the adjacent broken stone. This, I think, is a remarkable as well as an important fact, and it goes to show that there takes place an interchange of the temperature between the inner substances and the steel, and that in this class of steel highways we do not need to provide for expansion. Altogether, I find the steel road to verify all I have said about it, even as to cost, and with regard to traction advantages I am now able to give figures. I have made 20 trials, using a gaged spring balance, and find that the average force needed to pull the iron wagon, weighing 1,550 lbs., with a 16-ft. wagon-bed, is 2.5 lbs., which, reduced to a load of 2,000 lbs., means a traction force of 3.23 lbs. per ton.

The second letter is from Mr. Abel Bliss, of New Lenox, Ill., and is as follows:

I take the liberty of giving you my experience with a steel roadway which I placed in the public highway near my home, 4 miles east of Joliet, Ill. It was put down April 2, 1896, on a dirt road of typical Illinois soil, and consisted of a steel rail ¼ in. thick and 8 ins. wide, with a flange 3 ins. wide turned down on either side and a ¾-in. flange turned up on the outer edge to keep the wheels on the rails. These rails were let into the ground so the flat part rested on the earth, and were fastened together at the ends by fish plates, which are so constructed as to run the wheels onto the rails after passing a team. The earth between the rails was removed to a depth of 4 ins., and the space filled with gravel for a tread for the horses. These roads have been tested with all kinds of loads, including traction engines, and have retained their position very well. While the mud made the roads almost impassable here during the past winter, a team could have trotted on the roadway any day with a two-ton load. About 50 tons of steel per mile will be required, having the rails ¼ in. thick, which I think is ample.

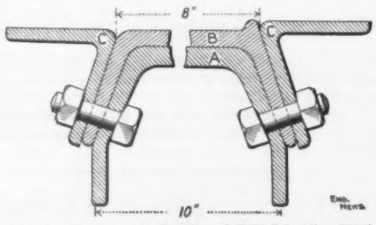


Fig. 3.—Transverse Section of Rail Joint for Steel Rail Highway.

We are indebted to the courtesy of Gen. Stone for the information from which this article has been prepared.

A NEW FLUSHING SYSTEM FOR WATER CLOSETS.

A new form of flushing system for water closets which seems to have many excellent features has recently been introduced in the Bowling Green office building, the Produce Exchange and some other large buildings in New York city. It is designed for use on either direct pressure or tank systems, and to work with ease and efficiency under any pressure, giving a quick flush of large volume at the start, and finishing with a long, slow after-flush of small volume.

This system dispenses entirely with the overhead flush tank which is a necessary feature of nearly all water closets now on the market, and substitutes for it a vertical pipe about 3 ins. in diameter, its upper end closed. At the foot of this is placed the water supply inlet and also the flushing valve. Fig. 1 is a perspective view of the closet and flush pipe, Fig. 2 is a section of the flushing valve, and Fig. 3 shows the closets, on as many different floors, supplied from one tank in the attic. As the supply pipe enters the water column at its base, an air pocket is formed in the top of the water column and the air is compressed to a pressure equal to that due to the head of water in the supply pipe. It will be evident that when the valve at the base of the water column is opened, this air will almost instantly force out enough water to enable the air to expand to atmospheric pressure. This gives a sudden and very powerful flush with a large volume of water. After this, if the valve is still open, the water will flow out slowly, being only under the pressure due to the head of water in the water column.

The compound flushing valve shown in Fig. 2 is designed to enable the large valve to be lifted from its seat with a moderate pressure upon the flushing lever, and to delay the closing of the valve until the slow after-flush is completed. As seen by the drawing, it consists of a small valve which can lift independently of the main valve for a short distance, and when so lifted relieves the pressure on top of the main valve which holds it to its seat.

To trace the consecutive operations: The lever is pushed down, lifting first the small valve and then the large valve with the piston to the top of the valve chamber. As soon as the large valve is unseated, the air compressed in the water column forces out the water to give the main flush. The weight of the valve and its attached parts causes it to begin to descend as soon as the lever is released; but it can only do this slowly on account of the contracted passage for the water to the upper side of the piston.

To adjust the apparatus to varying heads, a regulating ring is provided which can be screwed down to cover the ports by which the water escapes from the water column to the flush opening to any desired extent.

While the apparatus may appear complicated in operation, it is really very simple in its construction, and much less liable to get out of order than the float valves in the ordinary water closet tank.

The water column may be varied with the pressure in the supply system, being made long for a low pressure, and thus affording a supply in storage. In case the city pressure is not sufficient to supply the building, and a general supply tank is used, the water column can be supplied directly from this tank. The doing away with individual tanks for each water closet of course simplifies and cheapens plumbing work, and gives room for a window behind the space generally occupied. Of course, if for any reason it is desired to use a tank, the flushing valve can be used with it as well as with the water column.

Two other advantages of the water column are its noiselessness of operation, as compared with most flushing devices, and the small amount of space for the accumulation of foul air beneath the valve. In tank flushing closets the whole length of the supply pipe is filled with air, drawn

from beneath the seat after the flush. This air is driven down and out into the room by the rush of the flushing water.

To the water-works superintendent, always on the alert for plumbing appliances which use and waste the minimum amount of water, this device appears to us well worth a careful investigation, as it seems likely to give a thorough flush with a small volume of water, while the unusually heavy weight of both the valve and the head of water on it will hold the valve more firmly on its seat than is possible with the ordinary float valve, be-

Fig. 1.—A New Type of Water Closet Without Flush Tank. Made by the Kenney Sanitary Mfg. Co., 47 Dey Street, New York City.

sides which the play room is so small and the valve so designed that it cannot leak through horizontal displacement.

The valve is manufactured by the Kenney Sanitary Manufacturing Co., of 47 Dey St., New York city. We are indebted to Mr. D. T. Kenney, President of the company, for the information from which our description is prepared.

THE CENTRAL DOMINICAN RAILWAY.

The second line of railway to be built in the Republic of Santo Domingo was formally opened for traffic on Aug. 16, 1897. It runs from Puerto Plata, a city of about 10,000 inhabitants on the north coast of the island, and extends to Santiago, in the interior valley, a total distance of 42¼ miles. At present about 4.77 miles of the line between Puerto Plata and Bajabonico are Abt rock railway, which was built by Belgian engineers, but the intention is to change this to adhesion line, with a maximum grade of 3%. This will lengthen the line about 5.35 miles, making its total length 47.6 miles. The distance between the two termini in an air line is 25 miles.

The construction of the Central Dominican Ry. was begun in 1890 by Belgian engineers, under contract with the Dominican government. After building about eleven miles, part of which up the mountains was rack railway, as previously noted, the Belgians abandoned the work and it was taken up by the San Domingo Improvement Co., of New York, N. Y., which completed it to Santiago. This company has also completed surveys and begun construction on an extension from Santiago to Moca, 17½ miles. From Moca to La Vega the distance is 14½ miles, and an extension to the latter place would give the new line a connection with the Samana & Santiago Ry., which now runs from La Vega northeast to Samana, 60 miles.

Beginning at Puerto Plata the new line runs a short distance along the shore and then turns south and climbs the Sierra de Monte Cristi Mountains, the summit of which it crosses by an 800-ft. tunnel, at an elevation of 1,580 ft. From the summit the line descends to Santiago, which has an elevation of 575 ft. In crossing the mountains there was some fairly heavy excavation. The track is 30½ ins. gage, with 45-lb. steel rail laid on Georgia pine cross-ties in broken stone and gravel ballast. At Bajabonico there is a 175-ft. span steel bridge 89 ft. high above the water, and on the remainder of the American section there were twelve steel bridges, varying from 30 ft. to 150 ft. span, and some thirty small bridges of from 6 ft. to 13 ft. span. At Puerto Plata and Santiago the stations have iron frames and are roofed and sided with galvanized iron, but the way stations are of wood, mostly native. The locomotive rolling stock consists of four Abt rack locomotives, built by the Etablissements Cail, of Paris, France, and one combination rack and adhesion engine, built by the Baldwin Locomotive Works, of Philadelphia, Pa., in 1895. All the material for the Belgian section of the line was brought from Europe, but all the material, except rails, for the American section came from the United States.

At Puerto Plata the railway connects with a new wharf, built at a cost of $100,000. Regarding the traffic of the road, Mr. D. E. York, Secretary of the San Domingo Finance Co., writes us as follows:

Traffic inward will consist of miscellaneous imports mainly, while the outward freight will be made up of domestic products. Tobacco is one of the main crops, and is largely cultivated in the interior; also coffee, cacoa and fruits, for which the lands adjacent to the line are exceedingly favorable. Extensive forests of logwood, mahogany and other valuable woods will furnish a large amount of freight for many years to come, as well as the many new industries springing up in response to the new facilities for transportation.

The company last year requested its general manager, Mr. Edward Hall, well known in railway circles in the United States and formerly connected with the Chateaugay R. R., who has been in charge of the construction and preliminary working of the Central Dominican Ry. for some four years, to make a careful estimate of the immediate business to be expected. That report states that 19,500 tons of various freight, producing, with a passenger service of $18,000, a total of $380,000, may be safely counted upon. His estimate of working expenses is $160,000, leaving a net profit of $220,000, Dominican currency. These calculations are based upon the average of past crops, and make no allowance for increased traffic resulting from the opening of the road. The one item of tobacco produced for exportation this year was alone double that of any previous year. Besides this the American company obtained, in 1893, before the construction was proceeded with, a written guarantee from highly responsible shippers that the freightage between Santiago and Puerto Plata alone would amount to not less than 20,000 tons per annum for ten years at a rate not less than $20 per ton.

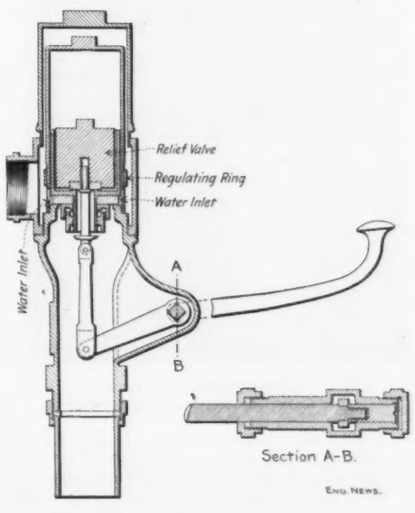


Fig. 2.—Vertical Section of Flushing Valve.

The Belgian engineers, in building the first eleven miles, deemed it essential to use the rack system, quite common in Europe, for short and sharp ascents. This rack line has been found very slow, expensive and difficult to operate and keep in repair, and is now being replaced by a detour adhesion line, which will not exceed 3% grade. A contract to build the American section was made with Drake & Stratton Co., of New York, N. Y., general contractors, but in January, 1896, they withdrew, and the company completed the construction in December of that year. The terminal buildings and side tracks and other matters were completed during the spring of 1897, and the official inauguration was held, with a general fiesta proclaimed for three days, when the road was formerly opened by President Heureaux, of the Republic, on August 16, amid great popular enthusiasm.

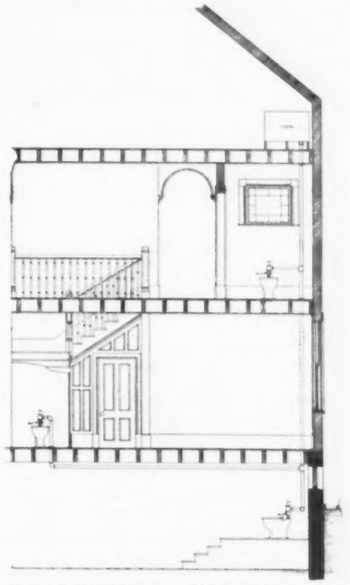


Fig. 3.—Three Water Closets on Different Floors Supplied from One Tank in Attic.

The American syndicate which built the road was headed by Messrs. Smith M. Weed, Willard Brown, Chas. W. Wells and E. D. York. We are indebted to Mr. York and Mr. Francis C. Nicholas, General Manager of the South American Exploration Co., 111 Broadway, N. Y., for the information from which the above description has been prepared.

THE ULTIMATE STRENGTH OF CONCRETE-STEEL BEAMS.*

By J. B. Johnson, M. Am. Soc. C. E.**

The strength of combination concrete-and-iron beams at the time the concrete cracks on the tension side has been investigated by Julius Mandl, in Germany,† by the method of least work, and by the writer in his work on "Materials of Construction," by another method, both of these giving the same equations. But on account of the low tensile strength of the cement concrete, this limit corresponds to a loading in the usual cases of only about one-third of the ultimate load the beam is able to carry before reaching either the compressive strength of the concrete or the elastic limit of the reinforcing steel rods. The cracks which appear on the tension side of the beam also, at this limit, are numerous and very small, being so hairlike that they are no detriment to the structure, even though occurring in a finished ceiling. This limit of strength, therefore, should not be taken as the ultimate strength of such beams, although the

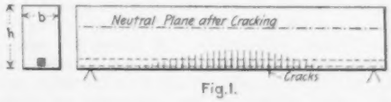


Fig. 1.

factor of safety used in practice would probably always keep the working loads well inside of this limit. It remains, therefore, to find a rational analysis of concrete steel beams which will be applicable to the case of such a beam after it has cracked on the tension side.

*Abstracted from a paper read before Sec. D. of the American Association for the Advancement of Science, at the Detroit meeting, Aug., 1897.

**Professor of Civil Engineering, Washington University, St. Louis, Mo.

†In Baumaterialienkunde, numbers 13, et seq.

The following assumptions are as applicable to this case as they are to ordinary simple beams:

1. In simple cross-bending the total compressive stress is equal to the total tensile stress acting on any right section of the beam.

2. A section plane before bending remains a plane after bending, and hence the deformation of any element varies directly as its distance from the neutral axis, and hence, within the elastic limit of the steel bar, the stress in it and in the unbroken part of the concrete may be said to follow this same law.

3. The tensile stress on the uncracked portion of the concrete below the neutral plane is so small and is exerted so close to that plane, that it may be neglected in this analysis. From these premises we may at once find:

$$y_2 = \sqrt{\frac{2\,a\,e}{b}\,\frac{E_s}{E_c}}. \qquad (1)$$

$$M_0 = f_s\left(\frac{b\,y_2^3}{3\,e}\cdot\frac{E_c}{E_s} + a\,e.\right) \qquad (2)$$

$$f_c = f_s\left(\frac{E_c}{E_s}\,\frac{y_2}{e}\right) \qquad (3)$$

in which

a = area of steel bar.

y_2 = distance from neutral plane to compressed side of beam.

e = distance from neutral plane to center of steel bar.

b = breadth of beam = distance between the steel rods.

E_s = modulus of elasticity of steel.

E_c = modulus of elasticity of concrete.

f_s = tensile stress per sq. in. on the steel bar.

f_c = maximum compressive stress per sq. in. on the concrete.

M_0 = moment of resistance of the beam for any assumed stress, f_s, in the steel bar, as the elastic limit.

By taking the value of f_s equal to the elastic limit of the steel or iron used, equation (2) gives at once the ultimate moment of resistance of the beam after the position of the neutral axis has been found. If the steel rod is placed too near the neutral plane, thus making $\frac{y_2}{e}$ relatively large, the compressive stress in the concrete, f_c, as shown by equation (3), may become so large as to make this the weakest part of the beam. The most efficient method of combining steel and concrete is, evidently, to place the reinforcing steel bars at the bottom of projecting ribs as is now done in some forms of fireproof construction.

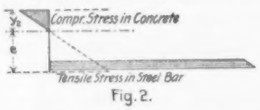


Fig. 2.

The above equations were first derived and used by Mr. A. L. Johnson, Assoc. M. Am. Soc. C. E.

A NEW PORTABLE LIGHT FOR OUTDOOR OR SHOP USE.

The accompanying cut represents the Buckeye lighting apparatus for use in factories and on construction works, and which can also be utilized for heating purposes, burning either crude or refined oils. It consists essentially of a cylindrical steel tank, containing oil under pressure, and a cast-steel vaporizing chamber mounted on an upright pipe.

In the figure, A is a back guard through which the air is admitted to the burner or vaporizing chamber B, the position of the flame (in a vertical plane) being adjusted as required by turning the burner on its brass elbow union bearing at C. The main valve D regulates the supply of oil to the burner, and E is a filtering plug to prevent dirt from being carried up to the burner. This plug requires cleaning only at long intervals. The air-cock is shown at F. The air-pump is mounted on the side of the tank, its handle being shown at G and its inlet valve at H. I is a plug for emptying the tank; K is the device for starting the light, and M is the plug of the hole for filling the tank. The weight of the apparatus is about 120 lbs.

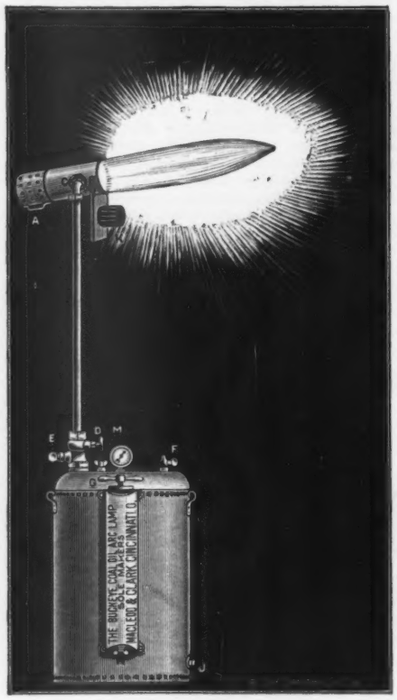
The tank is filled at least two-thirds full, leaving an air space of a few inches, and the valve H is then opened and the pump worked until the desired pressure is obtained (usually about 25 lbs.) when the valve is again closed. To start the light a small quantity of oil-soaked waste is put in the burner and lighted, and the door K then closed. In a few minutes, when the burner has become thoroughly heated, the door is opened and any residue of the waste removed, and then the oil supply valve D is slowly opened, when the oil will rush up the pipe to the jet of the burner, and into the hot chamber, where it becomes vaporized and emits a smokeless, white flame. The apparatus may be adapted to heating purposes by taking off the guard A. This will give a greater supply of air, resulting in a smaller but hotter flame.

The apparatus is manufactured by Macleod & Clark, 457 E. Front St., Cincinnati, O., and it is already in use in several works, including those of the Globe Foundry Co., of Cincinnati, and the Illinois Steel Co., of Chicago.

THE GATES OF THE CASCADES CANAL LOCK, COLUMBIA RIVER, OREGON.

(With two-page plate.)

This canal, authorized by the Government in 1877, and modified in plan in 1880 and 1886, has been built to overcome obstructions in the Columbia River at this point, and was formally opened to traffic on Nov 5, 1896. The Cascades of the Columbia River are located at the head of a narrow gorge, about 4½ miles long, by which this river crosses the Cascade Mountain range. In the first 2,500 ft. of this gorge, known as the Cascades, the river falls 24 ft. at low water, and below this point are rapids extending throughout the length of the gorge, and having a further fall of 12 ft. at low water to the end of the gorge. The object of the improvement is to obtain a low water channel 8 ft. deep; and with this end in view a canal, 3,000 ft. long, has been built around the Cascades, and this canal is provided with a lock 521 ft. long, between hollow quoins, 90 ft. wide, and having a lift of 24 ft.



A New Portable Light.
Macleod & Clark, Cincinnati, O., Manufacturers.

The original plans, as submitted by Major John M. Wilson in 1877, contemplated the passage of boats at stages not exceeding 20 ft. above low water; it being assumed that this was the maximum stage at which boats could ascend the rapids to the lower entrance of the canal. But the rapids were improved by removing rocks and cutting away projecting points, and after the completion of that portion of the work, in 1885, it became evident that navigation was practicable at much higher stages than 20 ft. The plan was then modified to provide for the utilization of the part of the canal between the upper lock-gate and the upper guard-gate, as a second lock; which made the canal available for all stages up to 42 ft. above low water.

Owing to lack of appropriations and other causes, the contract for the completion of the canal and the lock was not let until Dec. 27, 1892, when this contract was awarded to J. G. & L. N. Day. A plan of the lock as completed, together with a profile and section, are given herewith. The walls of this lock are made in the mass of Portland cement concrete, faced on the canal side with granite and basalt. All sills, cable-alleys, walls and copings, where wear or abrasion is to be expected, are also finished with stone. The culverts were built in the walls and faced with concrete, except at important points, where stone was employed. The miter-sills, hollow and recess quoins and valve-wells were built in the whole or partly finished with granite, brought from Spokane Falls, and this stone was used whenever dimension stone of sufficient size could not be obtained from the basalt near at hand. The average total cost per cubic foot of the stone used in 1891, when the government was doing the work direct by day labor, was as follows: Granite, $2.53; dimension basalt, $1.16; and face-basalt, $0.72. The 39-in. concrete culverts were built in sections 3 ft. long, with walls 6 ins. thick; these were allowed to set for 12 days and were then placed upon centering and built into the concrete walls. Including curved sections and not including setting, the average cost of these culverts was $3.56 per lineal foot.

The main culvert valves are of the "butterfly" type, and are 9 ft. 10½ ins. wide by 10 ft. 4 ins. high, by 21¼ ins. thick at the center and tapering to 2¾ ins. at the top and bottom edges. The center portion of these valves consisted of two 20-in. I-beams, held parallel to each other and 15 ins. apart by two solid steel forgings, 40 ins. long. The ends of these forgings, for a diameter of 10 ins. and length of 10¾ ins. were turned down to form trunnions. The valve proper is made up of steel plates, ranging from ⅝ to ¾-in. in thickness, according to position, supported by a skeleton framework made of ½-in. steel plates and 4 × 3 × ½-in. angles. On each of the trunnions a steel band was shrunk for the full length and turned down to ½-in. thickness, making the trunnions 11 ins. in working diameter. This was done to avoid the great expense of returning and truing up the trunnions when this became necessary; as the bands could easily be cut away and replaced by others, in position. These trunnions are carried in cast-iron plummer-blocks let into recesses in the walls of the culvert valve-chamber; the plummer-blocks being seated on heavy cast-iron plates, planed, carefully set and secured in place by bolts and grouting. The cap of the plummer-block is secured by wedges instead of bolts and the renewal of a "brass" would be comparatively easy.

The rectangular valve-seat was made as follows: A groove, 4 ins. deep by 8 ins. wide, was cut in the roof, floor and walls of the valve-chamber, and in this were bolted and grouted long castings carrying planed steel-bars, 1 × 4 ins., against which the valve rested. These valves are operated by horizontal hydraulic engines, placed in a pit on the top of the wall, and coupled to bell-cranks placed at the top of the valve-well, which in turn operate the valve-well rods and the valve itself. The culvert-valve engine is fitted with a cylinder, 15¼ ins. diameter and 6 ft. stroke, operated by a water pressure of about 220 lbs. to the sq. in. The gate-engine cylinders, which may be also here briefly described, are 18 ins. diameter with an extreme stroke of 15 ft. 1¼ ins.; though the actual stroke required is only 13 ft. 6 ins. The piston-rod extends through each cylinder head and the ends of the rod are each fitted to a cross-head carrying two grooved 45-in. sheaves, for the wire-rope. The cross-heads referred to have a long groove on each side, which fits and slides over a planed flange on the bed-framing; at each end of this framing is bolted a bracket carrying a 45-in. sheave with its axis inclined. This sheave receives the rope from the upper part of one of the cross-head sheaves and delivers it to the lower part of the other sheave, keeping all the parts of the rope parallel. The rope then

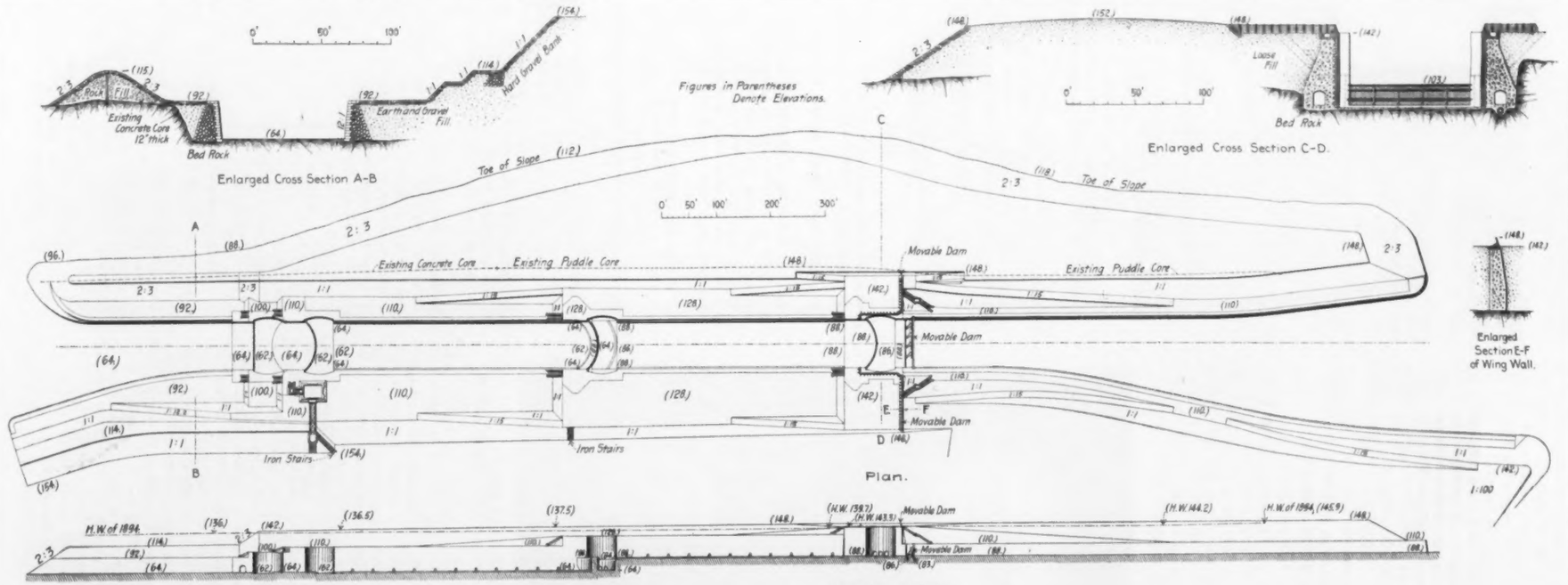


FIG. 1. GENERAL PLANS, PROFILE AND CROSS SECTIONS OF LOCK.

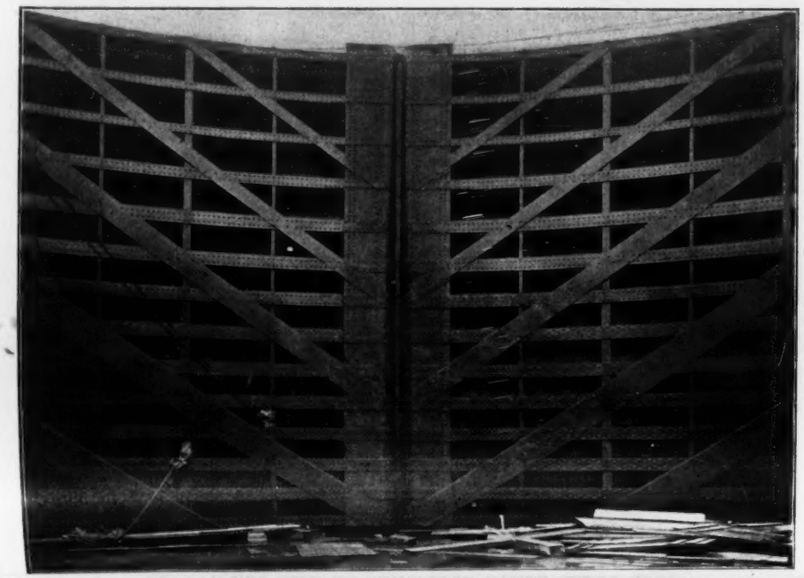


FIG. 3. INSIDE FACE OF COMPLETED LOWER GUARD GATE.

FIG. 3. INSIDE FACE OF COMPLETED LOWER GUARD GATE.

FIG. 2. GENERAL VIEW OF LOCK AND GATES UNDER CONSTRUCTION.

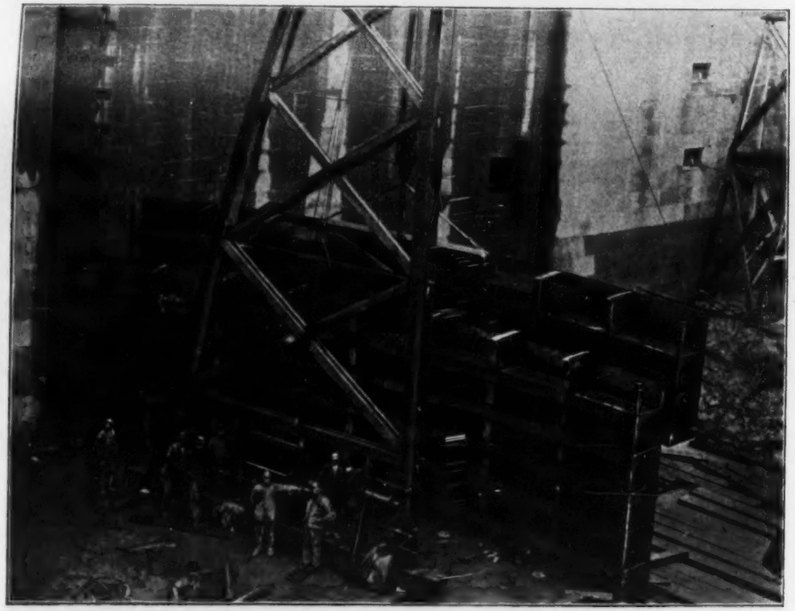


FIG. 4. RAISING A SECTION OF LOWER LOCK GATE, NORTH, INTO PLACE.

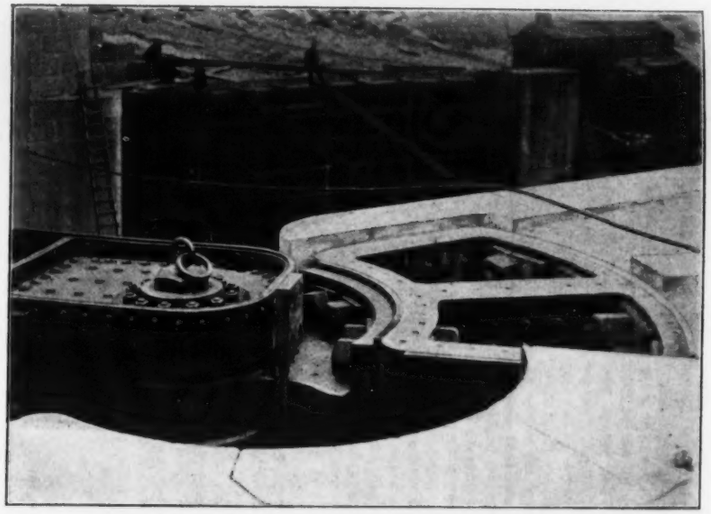


FIG. 5. UPPER CONNECTION OF GATE TO MASONRY, LOWER LOCK GATE, NORTH.

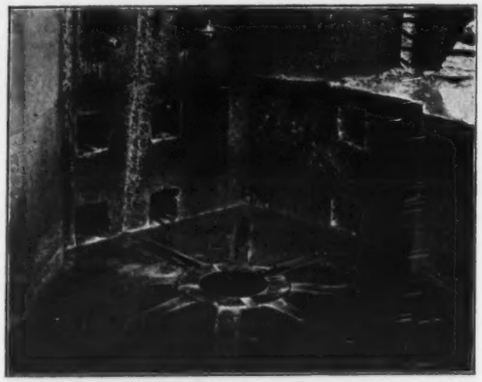


FIG. 6. CASTING FOR LOWER PIVOT OF UPPER GUARD GATE.

THE LOCK ON THE CASCADES CANAL, COLUMBIA RIVER, OREGON.

Engineers: Major Thos. H. Handbury
and Capt. Edward Burr,
Corps of Engineers, U. S. A.

Contractors: J. G. & I. N. Day,
Portland, Ore.,
and the Maryland Steel Co.,
Sparrows Point, Md.

FIG. 7. LOWER PIVOT OF UPPER GUARD GATE IN PLACE.

leaves the engine and is guided by two fair-lead sheaves at the top of the cable-alley to a vertical and a horizontal sheave at the bottom of this alley, and thence to a shackle on the lock-gate. Each engine thus opens the leaf of the gate on its own side of the canal, and closes the leaf on the opposite side. There are two engines for each pair of gates, except for the lower gate, and 2-in. pipes supply both these and the culvert-valve engines, under the pressure stated above. The turbine culvert-valve is of the ordinary type of gate-valve, with bronze face and is 39 ins. in diameter. An independent water-supply has been secured to be utilized as a motive power for all purposes. This water is conveyed a distance of 8,000 ft. in a 10-in. lap-welded wrought steel pipe, with Matheson lock-joint connections, and the total head above the upper lock-gate is 500 ft.

The lock and guard-gates, to the description of which this article especially applies, were all built by the Maryland Steel Co., at Sparrow's Point, Md., and shipped to the Cascades in large sections. The first section of a gate was put in place in February, 1895.

These gates are believed to be the largest canal lock gates ever built. They are built of steel and are of the single-skin type, swinging freely on pivots without the aid of rollers or flotation chambers. The details of this lock and its gates were worked out by Lieut. Edward Burr, acting under the direction of Major Thos. H. Handbury, the officer then in charge. Metal was selected in preference to timber for the gates, as the wooden gates would have been heavier and very difficult to frame and hang, and they would have been troublesome in operation, as their buoyancy would have required ballast when submerged. Douglas fir is the only available timber for this use on the Pacific coast; and this timber, while strong and obtainable in any dimension, would probably not last longer than 8 years in a lock-gate. As to comparative economy in first cost between wood and iron, Lieut. Burr says that this is more apparent than real. The life of well built lock-gates of white oak is not more than 20 years; and the gates of the Louisville and Keokuk canals had to be renewed or extensively repaired after 10 years' service. On the other hand, metal gates, in fresh water and subject to easy inspection, will last indefinitely and are really more economical. One objection to metal gates is that they are more rigid and less yielding than wood and are thus more liable to damage by vessels. But the facilities for repair are fairly good now on the Pacific Coast and are increasing, and no great danger is to be apprehended from this cause.

Each gate leaf, as made, has a developed length of face, exposed to pressure, of 53½ ft. The height of the lower guard-gate, above the miter-side, is 36 ft.; of the lower lock-gate, 46 ft.; of the upper lock gate, 40 ft., and of the upper guard-gate 54 ft. The following general data for these gates is given in Lieut. Burr's report:—

Clear opening between walls	90.00 ft.
Total span, from quoin to quoin	95.33 "
Rise of miter sill (one-fifth span)	19.07 "
Width of gates at ends	2.50 "
Width at center of leaf	3.00 "
Radius of face curve	70.37 "
Radius of back curve	75.13 "
Length of face, developed	53.55 "
Length of chord of face	52.27 "
Depth of recess	8.11 "
Miter angle	136° 23' 8"
Weight of one leaf, about	130 tons

These dimensions are for the skeleton outline of the gates, the corners, in construction, being rounded off by curves of 10-in. radius, so that the gates cannot "nip" outside of the meeting plates.

As will be seen by the photographs shown on our inset sheet, each leaf is divided horizontally by a number of plate-girders, or trusses with metal sheathing on the up-stream side only, while the back is braced by diagonal tie-plates. Vertical stiffness is given to the leaf, in addition to that coming from the posts, by three vertical plate girders and four intermediate sets of vertical angle bars braced by gusset-plates. The quoin and miter posts are built in single pieces and were shipped in one section from the shops. Each gate leaf was delivered in from 5 to 7 sections, according to the height of the gate. The quoin and miter posts carries vertical steel plates, 8 ins. wide by 1½ ins. thick; the plates on the miter-posts close against each other, and those on the quoin-posts close against similar plates fitted to cast lugs attached to the wall. The sill-plate on the bottom of the gate fits against a metal plate, 1½ ins. thick, on the miter-sill, and the entire contact around the gate is therefore of metal upon metal.

The gate pivots are eccentric, as regards the ends of the quoin-posts, so that as soon as the gate begins to open the 1½-in. plate on the quoin-post leaves the plate on the wall. The water-pressure upon the gate is transmitted to the wall through a series of horizontal girders, and no pressure is supposed to come upon the miter-sill. As shown in one of the photographic views, in erecting these gates the bottom pivot casting was first placed in position and held at the proper level by lead washers placed beneath it; a space of ¼-in. or more was left all about this casting, which space was later carefully grouted up with a thick grout of pure cement. The lower pintle, or pivot, was then inserted, and after the anchor box for the upper collar forging was fixed, the erection of the gate proper was commenced. The quoin-posts were first set up; then the body of the gate was erected, and finally the miter-posts. After the entire gate was set up and well bolted, the miter-post was given a slight predetermined inclination from the vertical, along the axis of the canal towards the convex side of the gate to compensate for the slight sag which would follow from carrying the entire weight of the gates on the top and bottom pivots. Riveting was then commenced and the gate completed, but without the diagonal braces; these braces were erected last, with the rivet holes for them drilled in place by hand-drills. The gates were then swung, the meeting face-plate carrier castings on the wall were adjusted by bolts so that they fairly and truly met the corresponding plates on the gates, and the space behind the castings was finally grouted from bottom to top. The construction of the top and bottom pivots is well shown in the photographs.

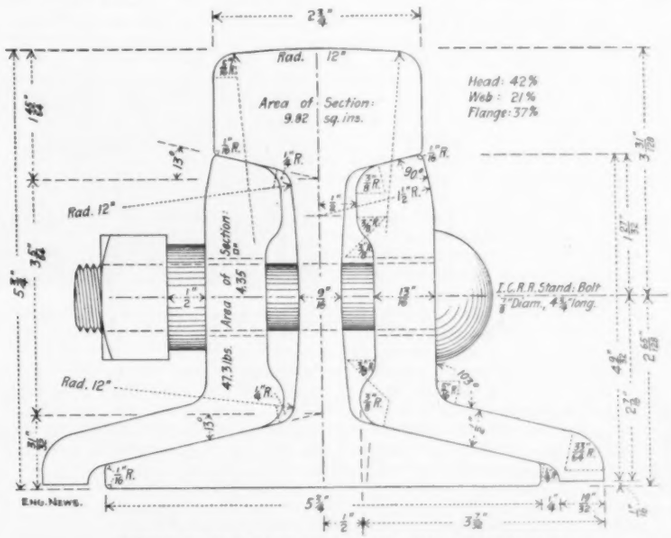
The cast steel plate, fastened to the miter-sill and upon which the gate closes, is made in 5 ft. segments, curved to fit the bottom of the gate. These segments were fitted after the gate was swung. The gates were all erected by the contractors, and the official report says that great credit is due them for the accurate and thorough manner in which they were constructed. There was not the slightest trouble in fitting the parts together, and they were handled by two derricks, of the housebuilder wall type, with a lifting capacity of 30 tons and a hoist of 60 ft. above the ground. The gates were so tight that the inner side of the lower guard-gate was pointed while there was over 30 ft. of water on the outside.

In a later issue we shall present some detailed drawings showing the construction of these gates.

The detailed cost of the canal, lock and channel improvement cannot be exactly stated, but the amount of $3,673,000 was appropriated for this general improvement between 1876 and 1896, inclusive. All of the work, except the completion of the lock and the canal, was done by the government under the day's labor system.

NEW 100-LB. RAIL AND SPLICE BARS FOR THE ILLINOIS CENTRAL R. R.

The Illinois Central R. R. has decided to gradually introduce 100-lb. rails on its main line, as noted in our issue of Sept. 16, and has adopted the section recommended by the rail committee of the American Society of Civil Engineers, which form of section is already in use on the Chesapeake & Ohio Ry. and some other railways. As it is some little time since we have had occasion to illustrate this form of section we give herewith a drawing of the Illinois Central's new rail, showing also the form of splice bars to be used. These bars are 40 ins. long, with six ⅞-in. bolts, 4¾ ins. long, the rails being laid with square supported joints, the same as the 75-lb. rails recently laid. The area of the rail section is 9.82 sq. ins., and the area of each splice bar is 4.35 ins., the weight of each bar being 47.3 lbs. The bars are 13-16 in. thick in the web, while the high-carbon steel splice bars of the New York Central R. R. are only 9-16 in. thick. These latter bars, also, have their flanges level with the base of the rail, while the bars for the Illinois Central R. R. are kept 1-16 in. clear above the rail base. The following table gives in comparative form the details of the 100-lb. rails of the



SECTION OF STANDARD 100-LB. RAIL, ILL. CENTRAL R. R.

(Conforming to the Standard Recommended by a Committee of the American Society of Civil Engineers.)

Illinois Central R. R. (Am. Soc. C. E. pattern) and the New York Central R. R. (Dudley pattern), the latter being the higher by ¼-in.

Dimensions of Standard 100-lb. Rail Section.

	Ill. Central R. R.	N. Y. C. & H. R. R. R.
Height, ins.	5¾	6
Width of base, ins.	5¾	5¼
Width of head, top, ins.	2¾	...
Width of head, bottom, ins.	2¾	3
Side of head	Vertical.	4 deg.
Depth of head, ins.	1 45-64	1⅝
Height of web, ins.	3 5-64	3 13-32
Depth of base, in.	31-32	31-32
Thickness of web, in.	9-16	19-32
Thickness of edge of base, in.	5-16	5-16
Height to c. of bolt hole, ins.	2 7-16	...
Radius of top of head, ins.	12	14
" top corners, head, in.	5-16	5-16
" bottom corns hd, in.	1-16	1-16
" top fillets, in.	¼	½
" bottom fillets, in.	¼	5-16
" sides of web, ins.	12	14
" corners of base, in.	1-16	1-16
Edge of base	Vertical.	Vertical.
Fishing angles (hd & base), deg.	13	14
Metal in head, per cent.	42	40.8
" web, per cent.	21	23.5
" base, per cent.	37	35.7

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Mailing addresses may be changed at will by sending both old and new address. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 326 means that subscription is paid to the 32d week (that is the issue of Aug. 12) of the year 1897; the change of these figures is the only receipt sent, unless by special request.

ADVERTISING RATES: 20 cents per line. Want notices, special rates, see page 28. Rates for standing advertisements sent on request. Changes in standing advertisements must be received by Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

The Interstate Commerce Commission has taken matters into its own hands with respect to the extension of time for the enforcement of the brake and coupler law, and has issued a general order respecting petitions for such extension which indicates that the commission rather enjoys the novelty of holding a whip hand over the railways.

This general order states that all such petitions filed before Nov. 15 will be heard by the commission at its office on Dec. 1, and at that time any person interested may present arguments for or against the granting of the extension. Every petitioning company, however, must file with its petition a statement showing the proportion of its freight cars which will be equipped with brakes and with couplers conforming to the law on Dec. 1, and also a statement of the cars equipped with brakes and couplers in each year since the passage of the law, and the number of freight cars which since that time have been bought or built without being equipped with automatic couplers and brakes. With this data before the commission it will be useless for a company's attorneys to plead that it has used great diligence in hastening the equipment of its cars if the facts show the contrary.

Besides this, each petitioning company must advertise by posting notices in its stations at terminals and junction points and by publication in some newspaper the fact that it intends to petition for an extension of time for equipping its cars, and that at the hearing on Dec. 1 the commission will hear arguments from any one for or against the petition. This advertising must be done thoroughly and in good faith. If we read correctly between the lines of the commission's order, the railway company which advertises its intentions in an obscure sheet and which posts the notices in its stations where no one will see them, will be apt to be turned down at the hearing on Dec. 1.

We fully believe, as we stated in our issue of Sept. 30, that the commissioners will in the end grant a general extension of time; but they are likely to give a very uncomfortable quarter of an hour to the officers of the railways which have followed the plan of equipping their cars with "any old thing," down to a recent date. As for the companies which paid no attention to the law for years after it was enacted, notwithstanding their ability to do so, they are likely to have to give assurances of a haste in completing their equipment in the future that will make amends for their past neglect before their petition will be granted.

What is the difference between a cantilever bridge and a suspension bridge? We presume most of our readers will at first think that this question is a very easy one to answer. The ordinary cantilever bridge and the ordinary suspension bridge are so unlike each other that it is easy to name many points of difference. But when we attempt to say which of these differences are essential, we find ourselves in need of more exact definitions of these two types of bridge construction than have ever been laid down, so far as we are aware.

In our issue of June 17 we published a series of views of European bridge structures of aesthetic design, among which was a view of the bridge over the Elbe at Loschwitz, Saxony. In the manuscript accompanying these bridge photographs, this structure was described by the author, Mr. Robert Grimshaw, as a "rigid suspension bridge." An inspection of the photographs convinced the editors that this was an error and it was described in the title below the cut as a cantilever bridge, though, by an oversight, Mr. Grimshaw's manuscript was not corrected to conform to this.

Since this was published we have received several letters calling attention to Mr. Grimshaw's error in calling this a rigid suspension bridge, and on the other hand Mr. Grimshaw has written us insisting that we are wrong in calling it a cantilever bridge. We reprint herewith the cut from

Bridge over the Elbe at Loschwitz, Saxony. Cantilever or Rigid Suspension? Which is it?

our issue of June 17, so that our readers may form their own conclusions. The bridge was illustrated and described by Mr. Grimshaw in the "Scientific American" of Sept. 26, 1896, but we do not find in that description anything which settles the question definitely as to the type of structure.

It will be seen by our engraving that there is a regular web system of bracing between the top and bottom chord, and although our view is too small to show it, there is a lattice-work sway bracing between each pair of web members extending from the top chord down to the intersection with the next web member. Certainly, then, the bridge is designed to and can act as a cantilever in carrying its load; and we think it altogether probable that the channel spans at least were erected as cantilevers by building out from the towers. On the other hand, there is reason to believe that a considerable amount of tension when the bridge is loaded is transmitted through the joint at the center. In other words, the top chord, although not of flexible construction, is under considerable tension throughout its length. Its form will be seen to approximate very closely to the catenary curve of the ordinary suspension bridge. If the structure were designed to act solely as a cantilever it would have greater depth of truss at the center and for some distance each side. Moreover, the bottom chord seems rather light to transmit the load that would come upon it if the bridge acted solely as a cantilever.

We have, then, a bridge which acts both as a suspension structure and as a cantilever in carrying its loads. Under which head shall we class it? Can any essential feature of either structure be laid down which will determine where this bridge belongs? We leave the question for our readers to answer, and will merely remark that the Loschwitz bridge is the most instructive illustration we have ever seen of the fact that the cantilever and the suspension types of construction possess many points of similarity.

A LESSON ON THE NECESSITY OF SYSTEMATIC WORK IN SUBSURFACE STREET CONSTRUCTIONS.

The tearing up of city streets to get at underground pipes for repairs and renewals is, even with the wisest management, always a nuisance to abutting residents and an obstruction to traffic. It goes without saying, therefore, that this work should always be carried on in such a manner as to make such nuisance and obstruction as small as possible. All cities of any importance recognize this fact in the restrictions which they place upon the making of street openings by corporations using the streets and by plumbers and others in making connections with water or other pipe mains or electric conduits. The liberty of the city itself to tear up its streets is naturally less restricted, but here, also, good practice in the construction of street conduits and subways everywhere requires that street obstruction shall be made as little as possible and shall continue for the least possible time. It is not to be expected, however, that perfect results will be any more frequently obtained in this than in other classes of city work, and many cases are known to every one who has lived in a large city, where, either through neglect of their duties by the city officials or because of defects in city ordinances governing these matters, the public is subjected to needless and sometimes long standing annoyances from obstructed streets.

As many of our readers are aware, a case of this kind in connection with the improvement of Fifth Ave., in New York city, has recently excited a large amount of newspaper discussion and criticism. But as is very frequently the case when engineering questions are the subject of public discussion, there has been a general failure to grasp the real situation and to apprehend the real lessons which are taught by the recorded facts.

These lessons deserve to be emphatically set forth, not only that a more just view may be had as to the situation in New York, but because they are of general interest to all concerned in municipal administration. We have, therefore, taken some pains to ascertain fully the facts regarding the Fifth Ave. work, and they may be summarized as follows:

In 1896 it became necessary to lay new sewers and water mains along a portion of Fifth Ave. The authority of the city to do this work was derived from two laws, enacted by the State Legislature of New York, one law authorizing the construction of the sewer, and the other law, the laying of the water mains. Still another act by the same body provided for repaving part of the avenue with asphalt after the underground work had been completed. These three laws, although referring to improvements on the same street, were entirely distinct from each other. Eact act also contained the familiar stipulation that the work must be done by contract, and the contract must be let to the lowest bidder. Under certain very probable conditions, it will be seen, each contract would be secured by a different person. This is, in fact, exactly what happened.

The work itself was of great magnitude, involving an expenditure of about $850,000, and was to be done on a street lined with costly residences and business houses. It may be briefly summarized as follows: (1) Laying a 48-in. water main on the west side of Fifth Ave., from 4th St. to 80th St.; (2) laying a 48-in. water main on the east side of the avenue, from 80th St. to 20th St., and then a 36-in. main from 20th St. to 4th St.; (3) laying a 12-in. water main on the west side of the avenue, from 57th St. to Washington Square;

(4) constructing a sewer on Fifth Ave., from 31st St. to Waverley Place; (5) repaving with asphalt that part of the avenue between 9th St. and 59th St.* The distance between 4th St. and 59th St. is approximately four miles, and the distance between 31st St. and Waverley Place is approximately one mile. Besides the main line trenching and pipe laying, the work, of course, included repaving, securing foundations, and the placing of numerous specials and connections.

The contract for the water mains was signed Aug. 26, 1896, and it stipulated that work should begin in ten days, and be finished in 400 working days. On July 25, 1896, the contract for the sewer work was signed, and it stipulated that construction should be completed in 150 days. Each contract included the furnishing of all material as well as performing all work, and the aggregate amount of the three contracts, as already stated, was about $850,000.

The specifications under which the contractors were required to work, and which were as usual a part of the contracts, contained special provisions intended to protect the public from unnecessary inconvenience. In laying the water mains the contractor was required to open but one side of the street at a time, and to construct a guard fence between the work and the half of the street left free for traffic. Only two blocks and two cross streets could be closed at one time on each line of trench, and as soon as ten blocks of the work had been completed the paving was to be replaced and the street opened for traffic. All stone and rock was to be removed as fast as it was taken from the excavation, and all earth that was not required for back filling was also required to be removed as fast as excavated. Only paving stones were to be placed on the sidewalks, and at least 6 ft. of the sidewalks were to be left unobstructed at all times. Pipe for one block only was to be delivered ahead of the work. One side of the avenue was to be left unobstructed to traffic at all times. The specifications for the sewer work required that the total length of excavation open should at no time be greater than 100 ft. In addition to these specific requirements, the specifications for both the sewers and the water main work stipulated that the contractors should make every reasonable attempt to prosecute the work rapidly, and to avoid offense to abutting property-owners.

So much for the Fifth Ave. improvements as they stood on paper. The actual conditions of progress and the methods of construction are best shown by giving briefly the charges of negligence made by the newspapers and by the residents on Fifth Ave., and the answer of the Department of Public Works to these charges. Broadly summarized the complainants charge: That trenches have been opened and left open in numerous cases for several days, and frequently for several weeks, and during these delays the dirt and paving stones have remained piled in heaps covering the pavement and part of the sidewalk in front of residences and shops; that, notwithstanding the urgent demand for haste, no work has been done at night, and too small a force of laborers has been worked at all times; and, finally, that lack of diligence in prosecuting the work and the total disregard of the convenience of the public have characterized the action of the contractors from the beginning of the work.

In reply to these complaints the officials of the Department of Public Works admit that the work has proceeded slowly, but claim that everything has been done to hasten it which the conditions encountered would allow. In order to make these conditions plain we have been at some pains to get a full statement of them from the city officials. This information we present as concisely as possible in the following paragraphs.

Like all other streets in New York, Fifth Ave. has had a large number of gas pipes, water pipes, electric conduits and subways of various sorts laid during the past few years, and no record whatever seems to have been kept of their location and character. The crossing of 26th St. may be taken as an example of the underground conditions encountered at street intersections. At this point there were five gas pipes, three subways for electric light and telegraph wires, one steam pipe and two general subways, in all eleven different lines of conduit, each of which was owned by a private corporation, and the existence and location of which were known to the city authorities only in the most general way. Along the avenue there were encountered one 20-in., two 36-in. and one 6-in. water mains, one 36-in., one 30-in., three 20-in. and one 16-in. gas pipes, besides smaller conduits, all of which had to be either moved or supported where intersected by a trench.

In handling these pipes, moreover, it was necessary to interfere as little as possible with the supply of gas, water, steam, electric service, etc., to the buildings along the street, and the careful handling and consumption of time which this necessitated can be appreciated by engineers. At various points rock was found for considerable distances whose existence was not previously known. At one place quicksand was encountered unexpectedly.

The sewers had to be constructed first because they were laid at the greatest depth. These sewers were not continuous for the reason that in the original construction many of the buildings had been drained at the rear or into the side streets, while in other blocks of more recent buildings the drainage was to sewers constructed in the avenue. The sewer work was a contract distinct from the other work, and had to be completed before the other work could be commenced. It was finished more slowly than was expected because rock was encountered over considerable distances where its existence was unknown or undefined. After the completion of the sewers the laying of the great water mains followed. This was an operation of great magnitude and had to proceed slowly under even the best conditions. The conditions were, as a matter of fact, very bad. In the first place the water mains could not be laid in the excavations that had been made for the sewers, and new trenches had to be dug. Since, too, the sewer had not been continuous its construction did not develop all the conflicting lines of pipe. It was very largely due to ignorance of these pipes that the laying of the water mains was so slow.

In every instance where these pipes were encountered it was necessary to suspend work until they could be removed or until special castings could be made to carry them over the water mains. The delay in every such case was from 10 to 14 days, and in one case it was three weeks. Among the obstructions encountered was the 20-in. water main previously mentioned, which for a distance of 13 blocks had to be moved inch by inch to one side a distance of 2 ft. without shutting off the water. In other instances the unexpected meeting with rock or quicksand made progress slower than was anticipated. During these delays it is admitted that the material from the trenches has remained in heaps on the pavement and sidewalks, but it is also maintained that as it had to be used for back filling this was the only practicable thing that could be done.

It is further claimed that night work was not practicable; first, because the trenching could be kept ahead of the pipe laying without working nights; second, because the calking of the pipe could not be done satisfactorily at night, and last, because the use of any flame for lights in proximity to the gas mains was likely to cause accident. For the first reason it was not considered that the use of trench machines would be of any advantage. The number of laborers worked on the excavation was, it is claimed, in all cases as great as could be worked to advantage, and if more had been employed they would simply have obstructed each other without accomplishing any more. The paving of the avenue had, of course, to wait until the other work was completed.

Such in brief are the accusation and the defense. The fair-minded man must conclude, we think, that the chief causes of such delay as has occurred lie behind any action of the Department of Public Works. Practically all that this Department can be held responsible for under any circumstances is the aggravation of the evils already existing. Whether or not the officials of that Department did the best that could possibly be done under existing circumstances is a matter on which opinions will doubtless differ, and would require a more exhaustive investigation than we have been able to make to decide. At present it seems best to us not to confuse the broader and more important lessons of the Fifth Ave. work with matters of mere personal or official efficiency, or the reverse.

Perhaps the first broad fact that will strike the reader is that we have here an excellent illustration of how the interference of the State Legislature in matters of municipal improvement may under certain conditions act to cause delay and to increase the cost of work. The sensible way, without question, to have done the work that has been done on Fifth Ave. would have been to let, in a single contract, at least the water pipe and sewer work. If a private corporation had been doing this work under competent engineering advice, this is without a particle of doubt exactly what would have been done. By doing the two jobs in conjunction it is plain to any one that the work could have been so arranged as to reduce both time and expense. The unprejudiced observer, it seems to us, must certainly credit the ridiculous system of special legislation which was used to get legal authority for making this improvement with much of the delay in carrying it out.

A second fact which is full of instruction is that a very large part of the delay and expense has been due to the previous and unregulated occupation of the avenue by the conduits and subways of rival, private corporations. We should not overlook the fact also that many of these conduits are needless. What valid reason is there, for instance, for having six enormous gas mains along Fifth Ave., as was noted above, or of having eleven separate subways and conduits cross the avenue at 26th St.?

It has been often shown that to attempt to establish competition in the gas business was absolutely futile, and that the gas consumers in any city where this is tried will eventually have to pay interest on a lot of useless gas mains. The Fifth Ave. experience shows that in addition to this, duplicate mains, mean expense, trouble and delay, whenever the street is dug up for other subsurface constructions.

But in this connection it deserves to be pointed out that the evils of a network of pipes under the street surface were made worse in the case of the Fifth Ave. excavations by the neglect of the Department of Public Works to keep any record of the number, size, location and character of these subways and conduits, owned by private corporations. So far, indeed, did the ignorance of this Department extend in respect to the subsurface conditions of one of the principal streets of the city, that it had only the vaguest idea as to whether earth or rock would be encountered in any particular place.

We need say nothing to our readers, we are sure, to convince them that every municipal government ought to have a complete and up-to-date record of every piece of subsurface construction under every street in the city. Such a record is not only a necessity to the rapid and economical carrying on of underground work; but its exhibit may at times turn the scale, and prevent the grant of further franchises to competing gas or electric companies involving further tearing up of the streets.

Again, the project to build subways or tunnels beneath the streets to receive all the conduits has always been condemned as too expensive to be practical; but who that sees the money spent on this latest Fifth Ave. work, and that upon the network of pipes and conduits above described, can doubt that a proper subway system under Fifth Ave. could have been installed for half the

* The different items and the itemized contract prices for the water main construction were published in Engineering News, July 30, 1896. The different items of sewer work and paving, and their contract prices were as follows:

Sewer Work:		
4,878 lin. ft.	brick sewer, per lin. ft.	$6.75
2,238 "	pipe sewer, per lin. ft.	5.00
72 "	iron pipe, per lin. ft.	4.00
170 "	12-in. culvert, per lin. ft.	50
35 "	curbing, per lin. ft.	.40
8	receiving basins, each	100.00
5,000 cu. yds.	rock excavation, per cu. yd.	3.17
200 sq. yds.	of flagging, per sq. yd.	.25
358,000 ft. B. M.	of timber, per M. ft.	10.00
Paving:		
67,000 sq. yds.	asphalt, per sq. yd.	3.85
16,000 cu. yds.	concrete, per cu. yd.	3.00
12,000 lin. ft.	curbing, per lin. ft.	.65

money that has been spent upon the pipe systems now buried beneath the pavement on that thoroughfare.

Another lesson which appears to us taught by the Fifth Ave. work, is the advantage under certain conditions of performing work by day labor rather than by contract. We fully believe that most classes of city work are best let by contract in open competition; but where the contractor must assume large risks, or where, as in this case, co-operation in carrying on several different pieces of work is necessary to economical and prompt execution, we are of the opinion that the city can carry on the work itself to advantage if it possesses or can form a proper organization.

Reference has been made above to the non-use of trench machines on the Fifth Ave. work. The examination we have been able to make of this matter has not been sufficient for us to form an opinion as to whether by the use of trench machines the obstruction of the streets could have been lessened, in this case, but it is fair to point out that in many cities their use is required by contractors for street work, on the ground that they entirely do away with the piling of dirt in the streets. The advantage of this in any city where street traffic is heavy is sufficient to justify this requirement, even if additional expense were involved; but the saving they effect in the cost of doing work, under usual conditions, is such that the city can gain the advantage of clear streets without additional cost.

BEHAVIOR OF NON-FIREPROOF STEEL BUILDING CONSTRUCTION IN THE DETROIT (MICH.) FIRE.

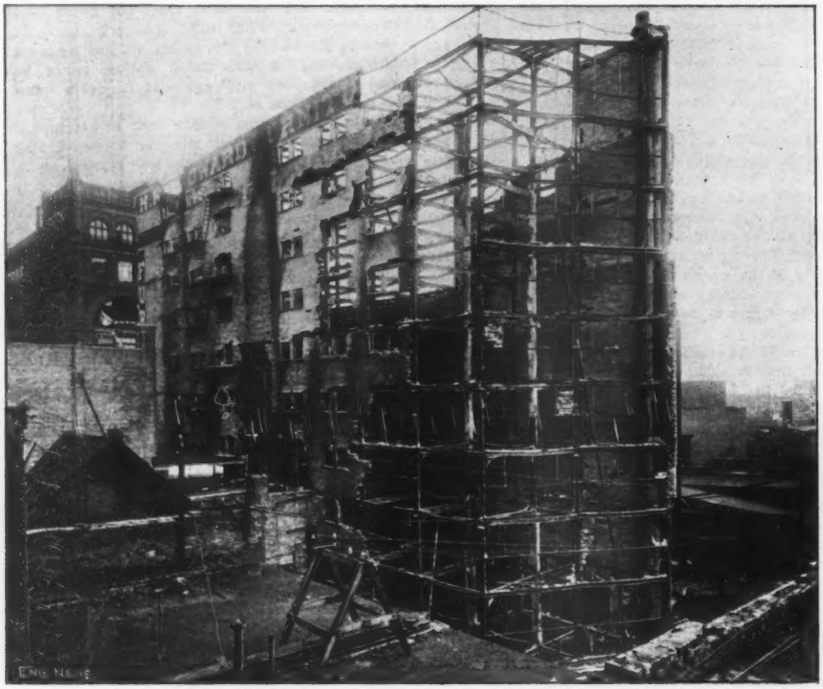
In our last issue we gave a brief description of the construction of the steel frame Leonard Building at Detroit, Mich., and the circumstances under which it was destroyed by fire on Oct. 7. Previous to receiving this article we had asked Mr. J. W. Schaub, M. Am. Soc. C. E., of Detroit, to make an examination of the building and to send us the essential particulars of the fire and the character of the construction, which was claimed by the owners of the building to be fireproof. In response to this request Mr. Schaub has sent us a photograph showing a somewhat closer view of the Leonard Building than was given in our illustration last week, and accompanied it with the following description:

Complying with your request of Oct. 8, I have made an examination of the ruins of the ten-story steel frame building which was destroyed by a fire on the morning of Oct. 7. The fire did not originate in this building, but was communicated to it from a building at the rear, across an alley about 20 ft. wide.

The building covered an area of 30 × 150 ft. and was about 125 ft. high in ten stories. The steel frame carried the walls on wall girders, which occurred at every floor. The walls for the two lower stories were of brick. Above this, the walls were of hollow tiling, bonded like ordinary brick work, which made a wall 12 ins. thick, excepting the front wall, which was of brick throughout. The photograph sent herewith shows the rear of the building where the fire started, from an adjacent building. The walls had openings for windows on all sides. These openings were not protected by shutters of any kind.

The steel frame consisted of columns and girders. The latter directly supported the floors and the walls. There were no floor beams of steel used in the building. The floors consisted of 2-in. planks laid directly on timber beams 12 ins. deep, spaced about 4 ft. 6 ins. c. to c. These beams varied in thickness from 5 ins. to 8 ins., the heavier beams occurring on the lower floors, and rested on shelf angles provided on the floor girders. The fireproofing on the exposed steel frame consisted of terra-cotta slabs about 1 in. thick. The floor girders were protected only on the bottoms and sides, leaving the tops bare. The wooden beams and planking were bare on all sides. The building was full of furniture and household goods in storage, and was advertised as a fireproof building.

The fire in the adjacent building exploded some oxy-hydrogen tanks used for making calcium light and it is claimed that the explosion of these tanks partially wrecked the rear wall of this building and exposed it to the flames. However, there is no evidence to prove this, and moreover the force of these explosions was insignificant. After the fire started the building was destroyed, as shown in the photograph, in about two hours. The so-called fireproofing offered no resistance to the flames. Whenever a column or a wall girder was warped by the heat the tiling would drop out like loose bricks. In fact, this building burned more rapidly than any of the surrounding buildings. There were six or seven buildings in all destroyed by this fire.



VIEW OF REAR OF LEONARD BUILDING, DETROIT, MICH., SHOWING INJURY TO STEEL FRAMEWORK AND TERRA-COTTA WALLS, BY THE FIRE OF OCT. 7.

The lessons taught by this fire are old lessons, but bear repeating. They are, first, that hollow tile is not a proper material to use for a fire wall, and, second, that a steel frame is not properly protected from a fire by covering the beams and columns with terra-cotta slabs that drop off as soon as the heat warps the beams, or as soon as the falling debris knocks them off, as it evidently did in this case. As far as the steel frame as concerned, I find the general alinement very good. A large number of columns and floor girders are badly bent, and in my opinion the entire frame will have to be taken down and repaired. It might be interesting to know that the original cost of this building was less than $50,000 or about 8 cts. per cu. ft.

ABSTRACT OF COMMITTEE REPORTS AT THE DENVER CONVENTION OF THE ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.

At the seventh annual convention of this association, held at Denver, Colo., Oct. 19, 20 and 21, interesting reports were presented on the following subjects: "Method of Heating Buildings Where Three or More Stoves are Now Used," "How to Determine Size and Capacity of Openings for Waterways," "Designs for Ice Houses," "Bridge Warnings for Low Overhead Structures," "Stock Yards and Stock Sheds, Including All Details of Construction," and "Bridge Floors." The third and the last of these reports will be published in a succeeding issue and we give herewith more or less complete abstracts of the other papers.

Best Method of Heating Buildings Where Three or More Stoves Are Now Used.

It is the opinion of your committee that for cleanliness, comfort and economy, hot water heating would be the best for a building of this size. While the first cost is greater than that for steam heat or stoves, still we believe that the first cost should not always be considered in a final decision. In erecting the building, while, with a hot water plant it would be necessary to build a cellar—which we would recommend placing under the baggage room—the cost of building one chimney would be saved. The cellar could also be used for storing the coal, which could be put in through a chute and thus avoid having an unsightly coal bin on the station grounds. All annoyance to passengers from ashes, dust, etc., would be avoided, and a great saving in coal and labor made, as it is no more trouble to care for a hot water plant, properly put in, than to care for one stove. All trouble from gas would be avoided, and certainly the rooms can be kept in a cleaner condition than where three or more stoves have to be constantly cleaned out and attended to. In the matter of economy, four stoves of a size necessary to heat the building would consume about 30 tons of coal per year, while a first class hot water system would consume about twelve tons per year. Here we have a saving of about 18 tons of coal each year, which your committee think would pay a large interest on the original investment.

The following would answer for a general specification for heating this building by steam:

The entire building to be completely warmed by direct radiation, located in the waiting-rooms, office, toilet and baggage rooms, connected to a system of steam mains which will be suspended from the ceiling of the cellar.

The main to be connected to a boiler which is to be located in the cellar close to the vertical flue. The steam supply branches to the radiators are to rise to and through the floor and to connect with each of the radiators, inserting in the connection, close to the radiator, a lock shield stop valve, for the purpose of controlling each individual radiator.

The return pipe is to follow the same general direction as that of the steam, and it is to be located on the side wall of cellar near the floor, substantially supported. Branch vertical returns are to connect to each radiator, and are also to be provided with stop valves in a similar manner to that described for the steam branches.

To furnish and efect a boiler of any well-known make, such as "Toulmin," "Gurney," or any other equally good pattern, and is to be of ample size to heat the building in the coldest of weather without forcing. The boiler to be provided and equipped with the usual set of fixtures, such as steam gages, try-cocks, safety-valve, damper regulator, fire tools and all other necessary fixtures to render it complete and ready for steam. The boiler to be covered in a proper manner with asbestos plaster at least 1½ ins. thick, applied over wire mesh. The boiler to be connected to the vertical chimney by means of a heavy wrought-iron smoke pipe, with a pivoted damper in its connection.

To have radiators located throughout the building, to be of the sectional type of an ornamental and neat finish. Each radiator to be provided with an automatic air valve of the "Onderdonk" or "Jenkins Bros." patent. They should be distributed as follows: Ladies' waiting-room, ladies' toilet, small waiting-room, office, gentlemen's waiting-room, baggage room. The above radiators are to be of ample capacity to warm the rooms in which they are located to 70° in the coldest winter weather.

After steam has been put on, all of the radiators and exposed piping throughout the building to be neatly bronzed with the best gold or silver bronze color, over a good sound coat of sizing. All the exposed iron work around the boiler and in the cellar to be painted with black asphaltum varnish.

The above represents a complete steam heating apparatus left in perfect running order, with steam on, and would cost in the vicinity of New York about $328. For the heating of this building by hot water, using the same number of radiators, locating the boiler in the same position, running the pipes in the same general

manner as specified for steam, equipping the radiators with valves, etc., including the same guarantee of temperature, etc., would cost about $379. The approximate amount of coal that would be consumed in the steam heating apparatus would be about 13 tons for a winter of six months, and, with careful management, the hot water system would consume ten tons of coal for the same period. This amount would, in all probability, be reduced if the caretaker of the boiler was careful.

How to Determine Size and Capacity of Openings for Waterways.

In our opinion, the desirable information to collect and compile consisted mainly of the methods actually adopted on railways to obtain results quickly and in a practical manner, and that the discussion of the theoretical and engineering methods employed would not fall within our sphere, as such questions are usually determined by the engineering department of a railway. Our aim was, therefore, more particularly to obtain information bearing upon the methods actually used by superintendents and engineers of bridges and buildings in determining the extent to which minor waterways may be reduced on existing lines, as the tendency of the day is gradually to shorten original temporary openings, or to replace trestling by permanent fills, which work usually falls under the maintenance of way departments. It would seem that in actual practice this question is determined in a number of ways, which can, however, in general be classified under the following groups:

1. By personal observation, and information collected on the ground, as to flood height, size of channel, openings in the vicinity carrying the same stream, etc. This general information guides in the final selection of the size of opening, but the actual determination is dependent on practical experience and individual views.

It might be said that, in the main, this seems to be the most usual method, if it can be designated as a method. It is, however, warranted and reliable in flat sections of the country where the bed and contour of a stream at flood times is known or well defined and the current more or less sluggish at all times. It is further probably the best method to pursue in thickly-settled sections of the country where other openings on the same water-course are generally to be found within a very short distance, and satisfactory deductions can be formed from a study of these and from information collected from parties familiar with the territory.

2. Drainage areas are prescribed for different sizes and kinds of openings, the limits for each opening allowing variations to be made according to the local conditions, topography, slopes, soil, rainfall, etc.

This method has many advantages if the table is prepared with reference to a specific section of the country, so that due allowance can be made for the variable rainfall conditions and the prevailing regional characteristics of the territory embraced. It does not eliminate, however, the personal equation in the question, especially as the range of the values in such a table necessarily has to be considerable. It will serve to indicate, so to say, at a glance the general class of opening required, but the final determination will be dependent on individual judgment and a personal examination of the district.

Mr. George J. Bishop, of the Chicago, Rock Island & Pacific Ry., wrote on April 12, 1897, as follows:

There are several things to be taken into consideration before deciding the size of culvert pipe or arch required for a permanent opening through a railroad embankment. On the C., R. I. & P. Ry. they send out a civil engineer to look up the drainage area of all permanent openings for waterways. The first thing to be done is to find the number of acres in the draw to be drained; the height of the highest water that has been in the draw, and whether land is cultivated or not; also, if there are small buildings along the draw, that are likely to wash down stream and block up the opening. Where the basin is small and has steep banks, and a number of small draws that run in the basin, and where the fill is about 12 ft. to 16 ft. high, it will require a larger culvert pipe or arch than for a long, narrow draw with a large basin and high embankments, as the water that has fallen by a heavy rain runs off before the water has got to the opening from the upper end of the draw. In Kansas, Nebraska and Eastern Colorado, we allow for drainage as follows, subject to the conditions above.

	Acres. Minimum.	Maximum.
1 line of 16-in. cast-iron culvert pipe.	20	40
1 line of 20-in. cast-iron culvert pipe.	30	60
1 line of 24-in. cast-iron culvert pipe.	45	90
1 line of 30-in. cast-iron culvert pipe.	70	140
1 line of 36-in. cast-iron culvert pipe.	110	220
1 line of 48-in. cast-iron culvert pipe.	180	360
6 ft. arches, 4 ft. side walls.....	240	400
8 ft. arches, 4 ft. side walls.....	320	550
10 ft. arches, 5 ft. side walls.....	500	850
12 ft. arches, 6 ft. side walls.....	720	1,200
16 ft. arches, 8 ft. side walls.....	1,280	2,300

3. Determination of the area to be drained and of the general characteristics of the country, soil and stream, which information is used in connection with an empirical formula giving the area of waterway required, based upon the drainage area with variable coefficients to suit the different conditions.

Considering the allowances that have to be made anyhow for greater safety, especially so as to provide, more or less, for cloudbursts and unusual contingencies, it can be said that for all minor openings an empirical formula suitably applied and not taken too strictly, supplemented by personal examination of the territory, practical experience and sound judgment, will give as good practical results as minute and careful engineering surveys and theoretical calculations.

Probably the best-known empirical formula for determining directly the proper area of a waterway and one that has been used most extensively in American railroad practice was advanced many years ago by Mr. E. T. D. Myers, president, Richmond, Fredericksburg & Potomac Ry., namely:

$$\text{Area of waterway in sq. ft.} = C \times \sqrt{\text{Drainage area in acres}}$$

where C is a variable coefficient. For comparatively flat ground or slightly rolling prairie, C is generally assumed as 1; for hilly ground as about 1.5; and for mountainous and rocky ground as high as 4. In exceptional cases even much higher values have been found to be necessary to correspond to the actual quantity of water as gaged at flood times. In regard to the proper values for the coefficient, Mr. Myers states: The coefficient should be derived from careful and judicious gagings at characteristic points within the region under treatment, and applied by a liberal hand.

It is generally claimed that this formula gives too large openings for very small drainage areas. Possibly this might be considered an advantage, as very small openings should never be made equal to the theoretical results, but ought to be made larger for practical reasons. Hence the formula in this respect certainly corresponds with practice if not with theory. Another statement made against this formula is that it gives too small values for very large openings. It has generally been understood that Mr. Myers intended this formula to apply to minor openings on railroads and not to important streams. For the latter there is no question that a more careful study of the conditions and environments is absolutely necessary, and the sole use of an empirical formula in connection with a coefficient established by snap judgment in the office or a hurried trip over the ground is entirely out of place.

A formula advanced by Prof. A. N. Talbot, of the University of Illinois, and stated by him to be "more as a guide to the judgment than as a working rule," is as follows:

$$\text{Area of waterway in sq. ft.} = C \times \sqrt{\text{Cube of drainage area in acres}}$$

in which C is a variable coefficient. "For steep and rocky ground, C varies from $\frac{2}{3}$ to 1. For rolling agricultural country subject to floods at times of melting snow, and with the length of valley three or four times its width, C is about $\frac{1}{5}$; and if the stream is longer in proportion to the area, decrease C. In districts not affected by accumulated snow, and where the length of the valley is several times the width, 1-5 or 1-6, or even less, may be used. C should be increased for steep side slopes, especially if the upper part of the valley has a much greater fall than the channel at the culvert."

Prof. Ira O. Baker, University of Illinois, in his book on "Masonry Construction," says, in regard to Myers' formula, that for small drainage areas it gives the area of waterway too great and for large drainage areas too small. In regard to Talbot's formula, he says that he had tested it and found it agreed fairly well with the experience of fifteen to twenty years, and that, in these tests, it was found that waterways proportioned by this formula will probably be slightly flooded, and consequently be compelled to discharge under a small head, once every four or five years.

Our deceased member, Mr. L. K. Spafford (Kansas City, Fort Scott & Memphis R. R.), made use of Myers' formula with a coefficient from 1 to 3. He wrote on July 18, 1896:

We have no iron-clad rules for deciding such matters, but usually, when the question of an opening arises, have a survey made, showing the area, and then make the opening from one to three times the square root of acres drained, the size of the opening depending on the topography of the ground. If the ground is level, we would probably use twice the square root of the acres drained. If the ground is hilly, we would use three times the square root of the acres drained.

Our deceased member, Mr. R. M. Peck (Missouri Pacific Ry. and St. Louis, Iron Mountain & Southern Ry.), wrote on June 11, 1896:

We determine the size of openings by a careful survey of the area of land to be drained. There is a great deal depends upon the natural lay of the land to be drained. If the country is very mountainous, and slopes of hills or mountains are steep and abrupt, we figure that one foot of area will drain four acres of land. Where the lay of the land is ordinarily flat and rolling, such as is found in good agricultural countries, we figure that one foot of area will drain six acres of land. These are the two extremes. We hardly ever go above or below these figures, but use all sizes between them, as the different and peculiar locations may demand."

This expressed in a formula would be:

$$\text{Area of waterway in square feet} = \frac{\text{Drainage area in acres}}{C}$$

where C varies from 4 to 6.

(4) Careful surveys of drainage area, slopes, gradients, and cross-sections of streams, determination of velocity of flow by observations or calculations, application of hydraulic formula to flow of water through various-shaped openings under different heads, at different stages of the water height, determination of probable average and maximum rainfall, the volume of water and the time within which it will reach the opening, etc.; from all of which information the shape and size of the opening is determined so as to carry off the water quickly, and without scouring the bottom of the stream, or injuring the structure.

After a careful consideration of the question, your committee decided, as stated above, that it would not be advisable to enter into a detailed discussion of this brauch of the subject.

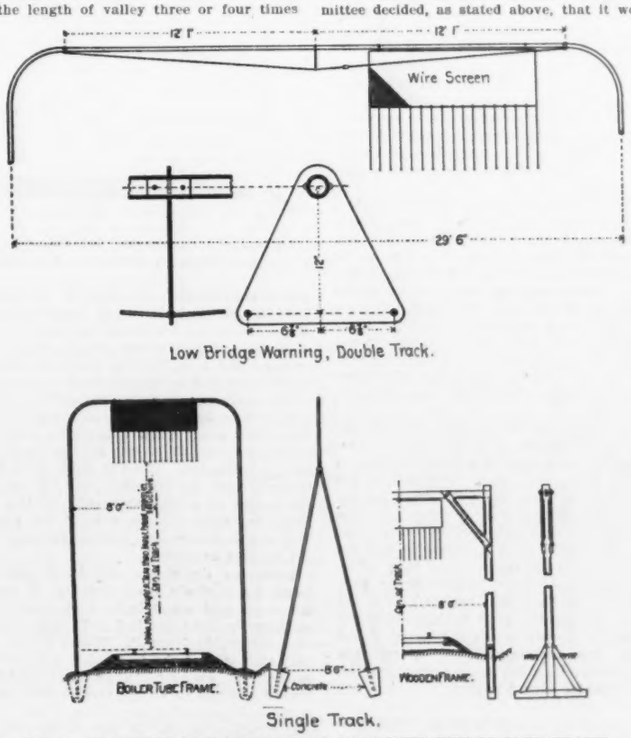


FIG. 1. STANDARD LOW BRIDGE TELL-TALE WITH BOILER TUBE FRAME.
Southern Pacific Co.

Bridge Warnings for Low Overhead Structures.

There are two radically different systems employed to accomplish the results desired. The system that is most extensively used, and which for convenience will be designated as the "vertical rope system," consists of

having light vertical ropes or wires (known as tell-tales, whip-cords, ticklers, or danglers) suspended over the track from a rigid horizontal wooden or iron bar or hung from a flexible wire or cable, the bar or cable being suitably supported on the outside of the track or tracks by upright posts set in the ground and properly braced and backstayed. In the other system, called frequently the Walling system, from the name of the leading patentee, and which can be designated as the "swinging arm system," a light horizontal swinging arm is projected out from a post planted on the outside of the track so that the arm will strike a man on top of a car, but at the same time swing out of his way as he passes on and then return automatically to its original position again.

It can be stated at once that the swinging arm system requires a separate arm for each track to be protected and further a separate post for each track, unless a post is set between tracks with arms on two sides. In the vertical rope system, any number of tracks can be crossed and the posts kept clear on the outside of all the tracks, the only question involved being to give the supporting bar or cable the proper stiffness, and to backstay or brace the end posts sufficiently to resist the inward pull at the top. Further, the testimony of the use of the swinging arm system on the Boston & Maine R. R. and on the Lehigh Valley R. R., indicates that it is not always safe. It has to be hung very delicately so as not to hit too hard a blow when struck, but in consequence, high winds affect it and blow it out of position. It can also be said that there is no positive assurance that in northern climates the pivoted joint connections will not become frozen and hence the apparatus dangerous under such conditions. Further, it is very easily damaged by trainmen striking it with brake-sticks or by swinging it around with great force or catching hold of it when passing slowly under it. There are other similar arrangements, in which light horizontal arms are counterweighted or variously arranged, but they have similar objections to those just mentioned.

Your committee is forced to consider that the vertical rope system is the best under most circumstances. There are numerous modifications of it in details, but the general principles remain the same. It will prove desirable to mention briefly some of the most important characteristics and practical features that should be considered in the design of a bridge warning.

Probably a very vital consideration is low first cost combined with durability. In this latter respect the iron tube supports and overhead bar used by the Southern Pacific Ry. (Fig. 1) are very advantageous, while the preservation of timbers by chemical means on all roads having facilities for such work within reach will also prove a saving in the long run. As the material is standard stock, it can be framed and treated in large batches at a time and placed in stock. Of course, a very low first cost can be obtained by adopting very crude arrangements, but it is a question whether possible damage suits for accidents resulting from imperfect structures will not far outbalance the slight additional cost of a suitable construction in the start.

According to the data collected by your committee bridge warnings seem to cost from $8 to $25 for a single track and from $20 to $30 for a double track warning. With a cable support, a large number of tracks can be crossed with comparative ease and small additional cost over that of a double track warning. One member places the extra cost as only 5 cts. per lineal foot. For an improved system using some means to prevent the ropes from catching on the cable, the probable extra expense would be from $3 to $5 per additional track over the cost of a double track warning. The standard iron tube frame bridge warning of the Southern Pacific Ry. costs $25 complete for a single track.

In regard to the tell-tales, ticklers, or danglers, the usual construction is to use ropes, ¼ to ¾ in. in size, knotted at the lower end and suspended from short pieces of wire or flat iron loosely or rigidly connected to the overhead bar or cable. In some cases the ropes are attached directly to the overhead bar or cable. It is a mistake to use too large a cord and especially a big knot at the lower end. In winter, ice will collect to such an extent that it is positively dangerous for a man to be hit by the end of one of these ropes. Rubber straps, sash cord, or old bell cord is frequently specified. On the Lehigh Valley R. R. the practice is to untwist old heavy rope and use one of the strands, which is economical and makes a softer rope. Some designs show wire or steel tape danglers, but this feature does not seem a good one, on account of rust and greater danger to men.

The ropes are generally spaced from 4 to 8 ins. apart for a distance of 5 to 8 ft. across the track. The lower ends are usually specified to be 6 ins. lower than the lowest point of the overhead structure for which they are to give warning, or a standard height of from 16 to 17 ft. above the rail is specified.

One of the important features is to prevent the ropes from being blown by winds or the engine exhaust, or more particularly from being tossed up by trainmen in such a way as to remain hanging on the top frame or bar. This is one of the most usual objections to the danglers. It can be overcome in a number of ways, several of which are indicated in the plans accompanying this report. The arrangement in use on the Chicago, Rock Island & Pacific R. R., namely, a horizontal hood over the top of the horizontal bar above the tell-tales, has the great additional advantage of protecting the ropes to a certain extent from the weather, and hence less liability to free and become stiff and hard.

In regard to the location of the warning with relation to the bridge proper, it should not be too far away, as there is too much chance for a brakeman to rise up on the car between the warning and the bridge. Various distances of from 200 to 300 ft. are specified, and in one case one-quarter of a mile is mentioned. The distance should certainly be limited to about 200 ft., and in yards where much switching back and forward is done immediately under an overhead bridge, the location should be closer, or even a second warning put up. Most roads seem to specify that bridge warnings shall be used at all overhead obstructions with a less clearance than 20 ft., although the range runs from 18 ft. 6 ins. to 22 ft.

An important maintenance feature is to arrange that the danglers can be easily repaired if torn off, tied up, or knotted together by brakemen standing on cars temporarily halted under the warning. The usual method of having a car hauled under the warning and workmen climb up on horses on top of the car is so cumbersome, especially out on the line, that it is put off from day to day, thus taking many chances with the life of the trainmen at night. The other system of setting up a ladder is equally objectionable. A tell-tale frame that can be let down, or if hung to a cable some arrangement to lower the entire cable, is generally preferable. It must be, however, practicable and guarded in such a way that tramps and unauthorized parties cannot tamper with it. Mr. W. B. Mitchell, of the Erie R. R., reports that he uses a small windlass locked in a box on the side post near the ground. The tell-tales are suspended from a cable, one end of which is wrapped around the drum of the windlass. When required, the cable is let down and after the repairs are made, hoisted into place, and a strain put on it. Special attention is directed to the device used on the Chicago, Milwaukee & St. Paul Ry., known as the "Nettenstrom Signal" (Fig. 2), which is

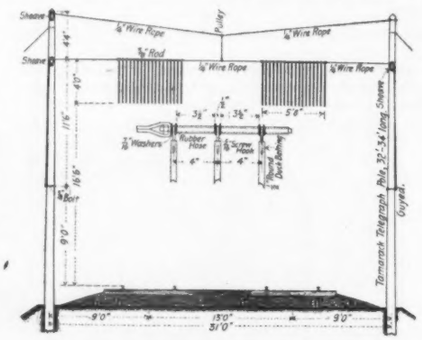


Fig. 2.—"Nettenstrom" Tell-Tale for Low Bridges. Chicago, Milwaukee & St. Paul Ry.

giving good service, according to the report of Mr. Onward Bates. This is one of the advantages of using a cable, and it has also the advantage that a large number of tracks can be spanned with it. But it has the disadvantage that it is liable to sag badly and requires good backstaying and bracing of the side posts.

The effort to counteract the ruling passion of brakemen to show their agility by climbing up on bridge warnings when a car stops temporarily under one has produced numerous arguments for and against a rigid overhead construction. If made rigid, no serious harm will be done, while on the other hand, if not able to support the weight of a man there will be less temptation offered, but more damage done if the feat is attempted. This is a double-edged question that your committee will not attempt to settle.

Comparing the single post frame and a double post frame for a single track warning, it can be said that the single post can only be used where there is an opportunity to bury the foot well in the ground or otherwise thoroughly brace it. Where this is not feasible, a post each side of the track should be used. Further, a double post warning can be more readily and quickly framed and put up on the ground, whereas a single post frame with projecting arm requires more carpentry work, that should preferably be done in the shop, and the post has to be set with greater care in reference to the track and much closer to it.

Stock Yards and Stock Sheds.

The bulk of this report consists of plans of standard stock yards used by different railway companies. There are 22 of these plans in all. Fig. 3 shows one of the more interesting of these plans. In regard to the general features of its subject the report says:

One of the largest and most important industries of the West is the stock business. When the stock is ready for the market it is necessary for the railway companies to have good facilities for the prompt handling of the shipments. In building stock yards the style, to a large extent, is governed by the location and right of way owned by the railway companies. Stock yards should be located on high ground, slightly sloping, so pens can be drained. If high ground is not available, the location selected should be graded up for that purpose. The size of stock yards depends on the amount of stock in the vicinity for shipment, and the number of shippers. Railway companies should have standard plans of stock yards, with details of construction for one or more pens so that in case additional pens are required, they can be added at any time, without making any alterations in the pens already built.

On account of the sharp competition for stock shipments between the railway companies, the shippers are sometimes allowed permission to use the stock yards for a week or more, until they can secure enough for shipment, or for a better market. This practice is expensive to railway companies, as they are compelled in some cases to erect stock sheds for the protection of stock from storms and heat. In cases of this kind railway companies, in order to keep the yards in proper condition on account of the cattle and hogs being held in the yards, are compelled to fill the holes in the yard with dirt, gravel, or broken stone, and in some instances, plank or pave one or more pens so as to make the yard passable.

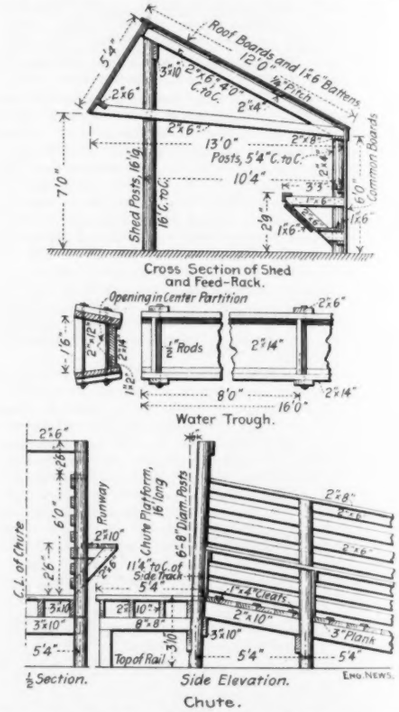


Fig. 3.—Standard Stock Yard and Stock Shed Construction, Chicago, Milwaukee & St. Paul Ry.

At some stations stock yards are not considered complete without loading and unloading chutes, with gang-plank or double-deck chute for loading double-deck cars, and also stock scales for weighing. All stock yards should have water and water-troughs in one or more pens, especially where hogs are handled; also a portable hog chute for unloading hogs from wagons. Fig. 3 shows the Chicago, Milwaukee & St. Paul Ry. Co.'s standard plans for stock yard and shed, with chute, fence, platform, water-trough and cross-section of shed and feed-rack.

ARCHITECTURE A "CLOSE" PROFESSION IN ILLINOIS.

Under an act passed by the Illinois State Legislature at its last session, architects desiring to carry on their practice in that state must secure licenses from a State Board of Examiners, which Board is entrusted with all the arrangements for conducting the necessary examinations and inquiries and for issuing licenses. The Governor has appointed the following gentlemen as members of this "Board of Examiners of Architects": N. Clifford Ricker, Professor of Architecture at the Illinois State University; Wm. H. Reeves, of Peoria, Dankmar Adler, William Zimmermann and

Peter B. Wight, of Chicago. The Board met at the Technical Club on August 3 and organized by electing Mr. Dankmar Adler as President and Mr. P. B. Wight as Secretary. The Board then adopted temporary rules, selected 1,001 Chamber of Commerce Building as its headquarters, and appointed a standing committee on examinations. The Board met again on Sept. 9 and adopted a form of notice to architects as to applications for licenses and affidavits. The form of license and design for a seal were also adopted. It was decided as a rule of order to hold regular meetings on the second and fourth Fridays of each month for the present. The following resolutions were also adopted:

That the policy of the Board with regard to the license of Architects who are not residents of the State of Illinois shall be as follows:

(1) That architects not residing in the State of Illinois, but who shall show to the satisfaction of the Board that on July 1, 1897, they were engaged in the practice of architecture in the State of Illinois as defined by Section 9 of the Act, shall be entitled to license in accordance with Section 5.

(2) That architects not residents of the State of Illinois who are not engaged in the practice of architecture within the same on July 1, 1897, may receive a license to practice architecture by complying with the terms of Section 4.

In a notice issued by the Board it is stated that the privilege extended by section 5 will expire on Dec. 31, 1897, after which another form of application for an examination under the provisions of the act will be furnished when requested. All licenses issued on the present form of application and affidavit and upon payment of the license fee of $25 will run from July 1, 1897, and will be for life, subject to the power of revocation vested in the Board by this act, and a fee of $5 is to be paid in each following month of July during the term of the license. The full text of this act is as follows:

A bill for an act to provide for the licensing of architects and regulating the practice of architecture as a profession.

Section 1. Be it enacted by the people of the State of Illinois, represented in the general assembly, that within 30 days after the passage of this act the Governor of the State shall, by the advice and consent of the Senate, appoint a State board of examiners of architects, to be composed of five members, one of whom shall be a member of the faculty of the Illinois State University, and the other four shall be architects residing in the State of Illinois who have been engaged in the practice of architecture at least 10 years. Two of the said practicing architects appointed as examiners shall be designated to hold office for two years from the date of the passage of this act, and the other two, together with the member of the faculty aforesaid, shall hold office for four years from the passage of this act; and thereafter, upon the expiration of the term of office of the person so appointed, the Governor of the State shall appoint a successor to each person whose term of office shall expire, to hold office for four years, and said person so appointed shall have the above specified qualifications. In case appointment of a successor is not made before the expiration of the term of any member, such member shall hold office until a successor is appointed and duly qualified. Any vacancy occurring in membership of the board shall be filled by the Governor of this State for the unexpired term of such membership.

Sec. 2. The members of the State Board of Examiners of architects shall, before entering upon the discharge of their duties, make and file with the Secretary of State the constitutional oath of office. They shall, as soon as organized, and annually thereafter, in the month of January, elect from their number a president and a secretary, who shall also be a treasurer. The treasurer shall file a bond for the penal sum of $5,000 with the Secretary of State, to be accepted by the Governor of the State, before entering upon his duties. The board shall adopt rules and regulations to govern its proceedings, not inconsistent with this act, and a seal, and the secretary shall have the care and custody thereof, and shall keep a record of all the proceedings of the board, which shall be open at all times to public scrutiny.

The secretary of the board shall receive a salary which shall be fixed by the board, and which shall not exceed the sum of $1,500 per year; he shall also receive his traveling and other expenses incurred in the performance of his official duties. The other members of the board shall receive the sum of $10 for each day actually engaged in this service, and all legitimate and necessary expenses incurred in attending the meetings of said board. Said expenses shall be paid from the fees received by the board under the provisions of this act, and no part of the salary or other expenses of the board shall be paid out of the State treasury. All money received in excess of the said per diem allowance and other expenses provided for shall be held by the treasurer as a special fund for meeting the expenses of said board, and the cost of an annual report of the proceedings of the State Board of Examiners of Architects:

Provided, however, that when the money in the hands of the treasurer at the time the annual report is rendered exceeds $2,500, the amount of such excess shall be paid into the State treasury to the credit of the State Board of Examiners of Architects.

Sec. 3. Three members of the board shall constitute a quorum. Special meetings of the board shall be called by the secretary upon the written request of any two members, by giving at least seven days' written notice of the meeting to each member, reckoning from the day on which the notices are postmarked, telegraphed or personally delivered. The board shall adopt rules and regulations for the examination of applicants for licenses to practice architecture in accordance with the provisions of this act, and may amend, modify and repeal such rules and regulations from time to time. The board shall, immediately upon the election of each officer thereof and upon the adoption, repeal or modification of its rules of government or its rules and regulations for examinations of applicants for licenses, file with the Secretary of State, and publish in at least one architectural journal and one daily newspaper published in the State of Illinois, at least twice, the name and address of each officer, and a copy of such rules and regulations, or the amendment, repeal or modification thereof.

Sec. 4. Provision shall be made by the Board, hereby constituted, for holding examinations, at least twice in each year, of applicants for license to practice architecture, and any person over 21 years of age, upon payment of a fee of $15 to the secretary of the board, shall be entitled to an examination for determining his or her qualifications. All examinations shall be made directly by said board or a committee of two members delegated by the board, and due notice of the time and place of the holding of such examinations shall be published, as in the case provided for the publication of the rules and regulations thereof. The examination shall have special reference to the construction of buildings, and a test of the knowledge of the candidate of the strength of materials, and of his or her ability to make practical application of such knowledge in the ordinary professional work of an architect, and in the duties of a supervisor of mechanical work on buildings, and shall also seek to determine his or her knowledge of the laws of sanitation as applied to buildings. If the result of the examination of any applicant shall be satisfactory to a majority of the board, under its rules, the secretary shall, upon an order of the board, issue to the applicant a certificate to that effect, and upon payment to the secretary of the board by the candidate of a fee of $25 he shall thereupon issue to the person therein named a license to practice architecture in the State, in accordance with the provisions of this act, which license shall contain the full name, birthplace and age of applicant, and be signed by the president and secretary and sealed with the seal of the board. If an applicant fails to pass said examinations his or her fee shall be returned. All papers received by the secretary in relation to applications for license shall be kept on file in his office, and a proper index and record thereof shall be kept by him.

Sec. 5. Any person who shall, by affidavit, show to the satisfaction of the State Board of Examiners of Architects that he or she was engaged in the practice of the profession of architecture on the date of the passage of this act, shall be entitled to a license without an examination: Provided, such applications shall be made within six months after the passage of this act. Such license, when granted, shall set forth the fact that the person to whom the same was issued was practicing architecture in this State at the time of the passage of this act, and is, therefore, entitled to a license to practice architecture, without an examination by the Board of Examiners, and the secretary of the board shall, upon the payment of a fee of $25, issue to the person named in said affidavit a license to practice architecture in this State, in accordance with the provisions of this act. In the case of a copartnership of architects, each member whose name appears must be licensed to practice architecture. No stock company or corporation shall be licensed to practice architecture, but the same may employ licensed architects. Each licensed architect shall have his or her license recorded in the office of the county clerk in each and every county in this State in which the holder thereof shall practice, and he or she shall pay to the clerk the same fee that is charged for the recording of notarial commissions. A failure to have his or her license so recorded shall be deemed sufficient cause for revocation of such license.

Sec. 6. Every county clerk shall keep in a book, provided for the purpose, a complete list of all the licenses recorded by him under the provisions of this act, together with the date of the issuance of each license.

Sec. 7. Every licensed architect shall have a seal, the impressions of which must contain the name of the architect, his or her place of business, and the words, "Licensed Architect, State of Illinois," with which he shall stamp all drawings and specifications issued from his office for use in this State.

Sec. 8. After six months from the passage of this act it shall be unlawful, and it shall be a misdemeanor, punishable by a fine of not less than $50, nor more than $500, for each and every week during which said offence shall continue, for any person to practice architecture without a license in this State, or to advertise or put out any sign or card or other device which might indicate to the public that he or she is entitled to practice as an architect.

Sec. 9. Any person who shall be engaged in the planning or supervision of the erection, enlargement or alteration of buildings for others and to be constructed by other persons than himself shall be regarded as an architect within the provisions of this act, and shall be held to comply with the same; but nothing contained in this act shall prevent draughtsmen, students, clerks of works or superintendents, and other employes of those lawfully practicing as architects, under license as herein provided for, from acting under the instruction, control or supervision of their employers; or shall prevent the employment of superintendents of buildings paid by the owners from acting, if under the control and direction of a licensed architect who has prepared the drawings and specifications for the building. The term building in this act shall be understood to be a structure consisting of foundations, walls and roof with or without the other parts; but nothing contained in this act shall be construed to prevent any person, mechanic or builder from making plans and specifications for, or supervising the erection, enlargement or alteration of any building that is to be constructed by himself or employes, nor shall a civil engineer be considered an architect unless he plans, designs or supervises the erection of buildings, in which case he shall be subject to all the provisions of this act and be considered as an architect.

Sec. 10. Architects' licenses issued in accordance with the provisions of this act shall remain in full force until revoked for cause, as hereinafter provided. Any license so granted may be revoked by unanimous vote of the State Board of Examiners of Architects for gross incompetency, or recklessness in the construction of buildings, or for dishonest practices on the part of the holder thereof, but before any license shall be revoked such holder shall be entitled to at least 20 days' notice of the charge against him, and of the time and place of meeting of the board for the hearing and determination of such charges. And on the cancellation of such license, it shall be the duty of the secretary of the board to give notice of such cancellation to the county clerk of each county in the State in which the license has been recorded, whereupon the clerks of the counties shall mark the license recorded in his office cancelled. After the expiration of six months from the revocation of a license, the person whose license was revoked may have a new license issued to him by the secretary upon certificate of the Board of Examiners, issued by them upon satisfactory evidence of proper reasons for his reinstatement, and upon payment to the secretary of the fee of $5. For the purpose of carrying out the provisions of this act relating to the revocation of licenses, the board shall have the power of a court of record, sitting in the county in which their meeting shall be held, and the power to issue subpoenas and compel the attendance and testimony of witnesses. Witnesses shall be entitled to the same fees as witnesses in a court of record, to be paid in like manner. The accused shall be entitled to the subpoena of the board for his witnesses, and to be heard in person or by counsel in open public trial.

Sec. 11. Every licensed architect in this State who desires to continue the practice of his or her profession shall, annually, during the time he or she shall continue in such practice, pay to the secretary of the board during the month of July a fee of $5, and the secretary shall thereupon issue to such licensed architect a certificate of renewal of his or her license for the term of one year. Any licensed architect who shall fail to have his or her license renewed during the month of July in each and every year shall have his or her license revoked, at the discretion of the board. But the failure to renew said license shall not deprive him or her of the right to renewal upon payment of said fee.

Sec. 12. Within the first week of December after the organization of the board, and annually thereafter, the secretary of the board shall file with the auditor of the State a full report of the proceedings of the board and a complete statement of the receipts and expenditures of the board, attested by the affidavits of the president and secretary subject to the approval of the State auditor.

A NEW SYSTEM OF ISOLATED CONTACT CURRENT DISTRIBUTION FOR ELECTRIC RAILWAYS.

A plan for distributing current on electric railways which does away both with overhead wires and with conduit construction is that known as the isolated contact system. In the street surface between the tracks are placed substantial metallic plates, projecting above the general level of the pavement a fraction of an inch. These are automatically charged with current from an underground feeder as the car passes over them and become dead as soon as the car has passed. The

advantages which such a system presents have attracted many inventors; and a few years ago, when opposition to the overhead wire still prevailed in many cities, and when the conduit system was still in an experimental stage, many prominent engineers believed that some system on the lines above set forth would be the coming electric railway. But the difficulties of practically operating such a system have proved very great. One difficulty is ensuring that current is absolutely cut off from the contact buttons except when the car is over them. A very few failures in this respect would be sufficient to condemn the system. Another difficulty is to secure durability and certain working in the switches, which have to make and break the circuit hundreds or thousands of times a day on roads of heavy traffic. Leakage of current is another difficulty. The track rails in all these systems carry the return current, and when the roadway is wet, leakage from the contact points across to the rail is apt to take place. Again it is difficult to secure freedom from noise in such a system due to the shock of the current collector striking the contact plates when the car is running rapidly.

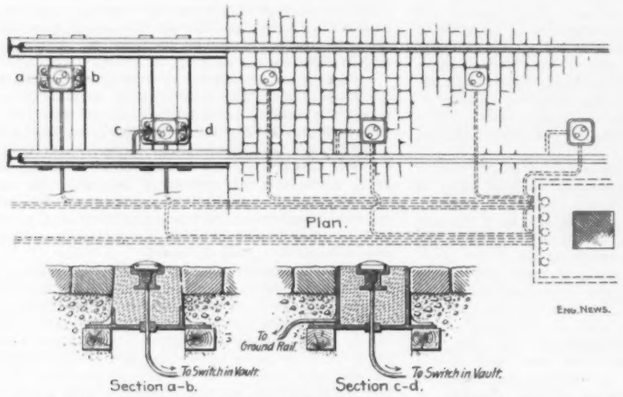


Fig. 1.—Surface Contact Electric Street Railway System of the General Electric Co. General Plan of Track and Vertical Sections Through Contact Points.

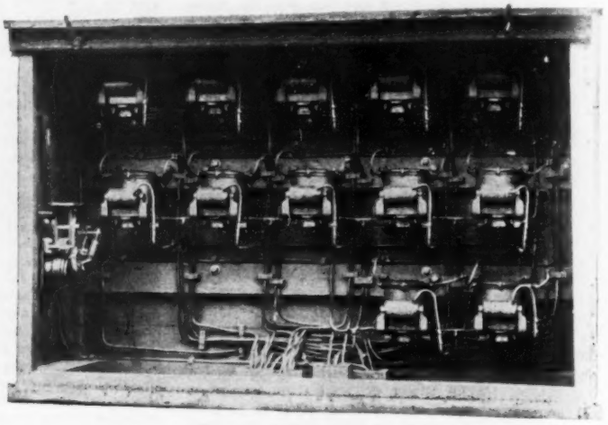


Fig. 2.—Group of Magnetic Switches in Case Attached to Wall of Building.

For some time the engineers of the General Electric Co. have been working upon a surface contact system, endeavoring to overcome the difficulties above described, and they have attained such a measure of success that the General Electric Co., through its French agents, has taken the contract to install this surface contact system on a railway three miles long at the famous European resort, Monte Carlo. The company is also now at work changing to a surface contact system the entire system of electric tramways in its shops and yards at Schenectady.

Among the departures from the work of previous inventors in this field which characterize this new system is the successful use of the "magnetic blow out" principle, so well illustrated in the General Electric Co.'s magnetic circuit breaker, to obviate the destructive arcing that frequently occurs when the switches operate. Another important change is collecting the switches for a considerable length of track and placing them all in a manhole between the tracks, or in a small closed box, which may be attached to the side of a building or placed at any convenient point. This largely obviates the sweating which occurred when the magnetic devices were enclosed in small boxes along the track.

In principle the system is extremely simple and necessitates practically no alterations in current practice, aside from the placing of the contact buttons, manholes and switches. The roadbed remains the same as for trolley roads. Manholes are built at convenient distances, and conduits for the feeder wires are placed along side or between the tracks. A single wire leads from each contact plate to its respective manhole, where will be installed one switch for each pair of buttons. Feeders are drawn into the conduits and tapped at each manhole exactly as must be done in any subsurface system, or the switches may be protected from moisture and tampering by a suitable box built against the side of houses along the line, as shown in Fig. 2. The cars and car equipment are identical with those running daily in all cities, with the addition of ten cells of storage battery, having a total capacity of 50 ampere hours at 5 amperes, the two 13 ft. contact shoes suspended under the car directly over the buttons and a switch on the controller. The battery and switch are in series with a portion of the motor resistance.

The operation of this system will be understood from the diagram, Fig. 3. A A' A" are the negative contact plates, and B, B' and B" are the positive contact plates. Both sets of plates are placed equal distances apart, a little less than one-half the length over all of the shoe. C, C' C" represent the automatic magnetic switches, and D, D' and D" their corresponding armatures or contact makers. F is the positive or collecting shoe, E the negative or return shoe, and C is the track return. H and K are switches which form part of the controller, the latter connecting in, or cutting out, the cells of a small storage battery, which is used only to energize the coil of the first switch through the plate over which the car passes in starting. After the armature of the first switch has been raised into contact and the line current has completed its circuit, the battery is cut out by the forward movement of the controller handle. In the diagram the car is to move to the right and all the magnetic switches are open. The handle of the controller is turned to the first notch and switches H and K are closed. Current from the battery flows through a small portion of the motor resistance to the shoe, thence to contact plate A' and through the coil C', completing the circuit to the ground. The coil C' thus energized, raises the armature D', closes the circuit through the automatic switch and the line circuit and completes its path through the motors and through the greater part of the motor starting resistance, as shown by the arrows through the positive plate B' and shoe F. Part of the return circuit goes to the storage cells, which are kept constantly charged, and part through shoe E, negative contact plate A' and coil C' to ground, keeping the coil C' energized and the automatic switch closed so long as the shoe remains on contact plate A'. Moving the controller handle forward from the first notch to the second notch opens the switch K, cuts out the battery and sends all the return current through the coil C'. The shoes E and F in the diagram are a little longer than the distance between contact plates. Thus, when the car moves forward slightly, the shoe will be in contact with the two contact plates A and A' and the return circuit will divide, half going through coil C' and half through coil C, energizing both and closing the armatures in the switches D' and D. The car moves forward and the shoe passes beyond the contact plate A'. The circuit in the coil C' is broken, the armature D' drops, cutting out entirely positive plate B", leaving it dead, but allowing B' still to receive current through the closed switch at D. Shoe F moving forward from

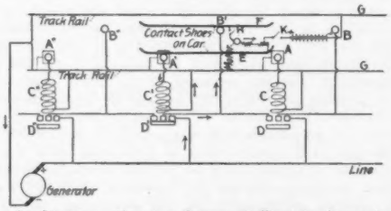


Fig. 3.—Diagram Showing Course of Electric Currents in Surface Contact Street Railway System.

makes contact with plate B before it leaves plate B' and the current is uninterrupted in its flow.

The form of the contact plates is shown in Fig. 1. They are first set in iron boxes and then surrounded by insulation. The contact plates consist of two parts, a wearing piece screwed into a support and held by a spring washer. This wearing piece can be removed readily without disturbing the support. The standard shoe is 13 ft. long, the ends being curved upward slightly to prevent catching. The shoes are supported from the axles and have a slight upward and downward movement to allow for any irregularities in the height of the contact plates. The amount of drop in the shoe is regulated by a set screw.

SURVEYING MINING CLAIMS.*

By Charles Tappan.

Surveys of mining claims by United States Deputy Mineral Surveyors, for the purpose of securing a patent from the United States, "must close within five-tenths of a foot in one thousand feet." (See Manual for 1895, page 10.) This requires an accuracy in the azimuth of the courses within two minutes of the true meridian. To get results within this small limit of error and to run from 5,000 to 8,000 ft. of lines per day over a rough mountain country is what a deputy is usually expected to do. The work is naturally divided into two heads, the transit work and the chaining.

To "deflect a course from the true meridian" with an error of only two minutes, it is necessary to have a good instrument. Personal habits and tastes will cause one man to prefer an intrument that another might consider very undesirable. My own preference is for a very small and light transit, the instrument and tripod together weighing about 12 lbs. and not encumbered with any solar apparatus, except a prismatic eye-piece to take direct observations on the sun. Not being familiar with the solar compass, I shall not attempt to discuss it merits, but will merely say that I have heard it reported by members of this Society as being capable of setting off a line with only one minute of error. Excellent results can be obtained by direct observations on the sun and reducing the observations by the formula

$$\cos.\ \tfrac{1}{2}\,Az = \sqrt{\frac{\cos.\ S.\ \cos.\ (s - p)}{\cos.\ \Phi\ \cos.\ h}}$$

where Φ = latitude, h = sun's altitude, p = sun's polar distance, and s = half sum of the three. There are sev-

* A paper read before the Montana Society of Engineers and published in the "Journal of the Association of Engineering Societies."

eral other solutions of the triangle, but the foregoing is the shortest. When s is greater than 84° this formula should not be used, because the cosine of large angles varies so rapidly. It is better, in such cases, to use the formula:

$$\sin. \tfrac{1}{2} Az = \sqrt{\frac{\sin.(s-\Phi)\sin.(s-h)}{\cos.\Phi \cos. h}}$$

Instead of depending on one sight at the sun and one reading of the circles, it is better to take either two or three sights at the sun with the telescope erect and then two or three with the telescope reversed (to do this it is necessary to have a full vertical circle); read the horizontal and vertical circles at each sighting and take the mean for the computation. This corrects errors arising from non-adjustment of instrument, especially errors in the collimation, from unequal height of standards and in the vertical circle. It takes only a few minutes longer to take the several sights and readings.

Always take a sight at the mark or foresight after observing the sun, to be certain that the transit has not moved during the observations. If the tripod has been wet, and if the observation is made the first thing in the morning, the heat of the sun may easily turn the transit two or three minutes. If possible, observations should be taken both before and after noon. The latitude usually offers the greatest difficulty in this method of getting the course. It is so often inconvenient to take a latitude observation at noon, that the great majority of these computations are made from latitudes calculated from the public surveys. As the error in latitude, for a morning observation, causes an error in the result with an opposite sign from that of an afternoon observation, the mean of the two, provided they are taken at equal hours from noon, should give the correct azimuth. By using Professor Johnson's "Tables of Error in Azimuth by Solar Compass" (reprinted in Gurley's "Ephemeris"), one can compare morning and evening observations taken at different hours from noon. For example, observations at latitude 40° at 10 a. m. and 5 p. m. give a difference of four minutes in azimuth. By the table, the morning observation would be 2.6 minutes, the evening observation 1.3 minute out, and the latitude one minute out. By making a new set of computations with corrected latitude, one can ascertain whether the difference is actually occasioned by using the wrong latitude, or by some other error. If the former, the observations may be considered correct. If the latter, a new observation should be made.

In running lines, it is not usually necessary to use hubs with tacks. Almost always, in a mountainous country, unless the timber is heavy, a backsight or a foresight upon a distant object makes it easy to keep a line straight within 1 in. in 1,500 ft., without being over-careful in centering at each hub. It is very convenient, for future use, to sketch, in the field-book, the object used as a sight, and show the cross wires in the sketch.

The long, thin steel tape is now almost universally used in chaining in this kind of surveying. The length of tapes depends greatly upon the character of the country, whether rolling hills, rough, rocky mountains, timbered or open. In the Upper Yellowstone country I first used a 300-ft. tape, but the country was either so exceeding rough, or else so heavily timbered, that about as rapid progress could be made with a 200-ft. tape. In Utah, especially in the foothills, distances of 500 ft. and more can very frequently be covered with one stretch of the tape. Experiments on a carefully measured base 492.4 ft. long, across a gulch, showed that a 500-ft. tape could be stretched by two men of ordinary strength, using a pull of probably 70 lbs., to within less than one-tenth of a foot of the actual distance. The pull was not measured by a spring-balance. It was as heavy a pull as could be conveniently made by a 150-lb. man, with the tape held as high as the telescope of the transit. In these experiments the tape was suspended clear of all supports, the angle of elevation, from one station to the other, was 5°, the length of tape between stations 494.3 ft., which, multiplied by cosine 5°, is = 494.42 ft. The tape was an ordinary Roe & Sons tape, marked every five feet with brass or copper plates, and every foot with a rivet. It is best to measure from the end of the telescope axis, and to measure the vertical angle to the hand of the head chainman. The precision with which the vertical angle should be measured depends upon the steepness of the slope. For slopes less than 20°, it is sufficient to read to 15 minutes. For reducing the measured distance to the horizontal, the most convenient thing to use is an old-fashioned traverse table, such as is found in Scribner's "Pocket Book," or Roe's "Pocket Book." These have distances to one hundred for each ¼ degree. As the tables are to two places of decimals, they can be used for distances up to 1,000 ft. for one decimal.

The error that most frequently enters into this method of chaining is that of reading the tape length 10 ft. wrong; e. g., one has the 178-ft. rivet, the first thing noticed is that the unit is 8, and as the 180-ft. plate is the one seen first, the distance may very easily be written 188 in the note-book. By having the back flagman hold the back end of the tape upon the last station, one can double chain at every line at the expense of very little extra time, except where the country is so open that the head chainman can proceed before the deputy reaches the next station. It is a very good practice to check by stadia. As stadia rods are always cumbersome, it is desirable to find some good substitute. A piece of stout canvas about one inch wide, 6 ft. long, and painted like a Philadelphia leveling rod, with a plumb and bob fastened to one end, can be easily read up to distances of five hundred feet, and when held by the top is sure to be plumb. This pocket rod is also very convenient in setting hubs that are hidden by intervening rocks or low brush, and for measuring distances to corners of buildings and other improvements, where extreme accuracy is not essential.

A very pretty check on the chaining of long lines can be made whenever some distinct object is visible from both ends of the line and from one or more points along the line. Say the line is 1,500 ft. long, and at the start a dead tree-top is seen 30° to the left. By measuring the angle to the tree-top at 500, 1,000 and 1,500 ft., one has the base and two angles of three adjacent triangles. If the line common to two triangles is the same length when computed from either triangle, it follows that the line measured is correct. It takes but a few seconds to measure the angles, and a few minutes to make the computations. If the object is properly situated, it can be used as a check on the end lines.

STATISTICS OF RAILWAYS IN THE UNITED STATES FOR THE YEAR ENDING JUNE 30, 1896

The Statistician of the Interstate Commerce Commission, Prof. Henry C. Adams, has furnished to the press an advance abstract of the forthcoming ninth annual statistical report of the Commission. From it we take the following figures of principal interest to our readers:

Mileage.—The total railway mileage in the United States on June 30, 1896, was 182,776 miles, there being an increase of 2,119 miles, or 1.17%, during the year. The aggregate length of railway mileage, including all tracks, on June 30, 1896, was 240,129 miles, the increase being 3,234 miles. The length of second track was 10,685 miles; of third track, 900 miles; of fourth track, 764 miles. The mileage of yard track and sidings was 44,912 miles. The number of railway corporations, June 30, 1896, was 1,985. Of this number, 1,008 maintained operating accounts, 782 being classed as independent operating roads, and 226 as subsidiary operating roads. The operated mileage affected by reorganization and other corporate changes during the year ending June 30, 1896, was 13,271 miles, of which 11,734 miles pertained to reorganized roads.

Equipment.—The total number of locomotives in service on June 30, 1896, was 35,950, or 251 more than on the same date of the preceding year. Of this number 9,943 were passenger locomotives 20,351 were freight locomotives, 5,161 were switching locomotives, and 495 were unclassified. The number of cars of all classes in service was 1,297,649, indicating an increase of 27,088 cars during the year ending June 30, 1896. The number of cars assigned to the freight service increased 25,768, being 1,221,887. It appears that the railways in the United States employ 20 locomotives and 713 cars per 100 miles of line. It is shown that 51,471 passengers were carried and 1,312,381 passenger miles accomplished per passenger locomotive. It is also shown that 37,634 tons of freight were carried and 4,684,210 ton-miles accomplished per freight locomotive. The total of equipment, including in the term locomotives and cars, on June 30, 1896, was 1,333,599. Of this number, 448,854 were fitted with train brakes, and 545,583 with automatic couplers. The increase in equipment during the year was 27,339, and while the increase in the number fitted with train brakes was 86,356 and the increase in the number fitted with automatic couplers was 136,727, the comparison shows that much remains to be done before the total equipment of railways will be furnished with the automatic appliances mentioned.

On June 30, 1896, the number of passenger locomotives fitted with train brakes was 9,816, and the number of freight locomotives was 17,921. The number of passenger locomotives fitted with automatic couplers was 4,503, out of a total of 9,943, and the number of freight locomotives was 3,373, out of a total of 20,351. The number of passenger cars fitted with train brakes on June 30, 1896, was 32,413 and the number fitted with automatic couplers was 31,846, out of a total of 33,093. The number of cars in freight service fitted with train brakes was 379,058, and the number fitted with automatic couplers was 500,233, out of a total of 1,221,887.

Employees.—The number of men employed by the railways of the United States on June 30, 1896, shows an increase of 41,586, being 826,620, which gives 454 men per 100 miles of line. The corresponding figures for the year ending June 30, 1893, were 873,602 and 515. For the first time, a summary showing the amount of compensation paid to the several classes of railway employees is presented in this report. It includes the compensation of over 99% of the employees for 1895 and 1896. The aggregate amount of money paid in wages and salaries, as shown in the summary for the year ending June 30, 1896, was $468,824,531, or 60.65% of the total operating expenses of railways. The aggregate compensation for 1895, was $445,508,261, or 61.38% of the total operating expenses.

Capitalization and Valuation.—The amount of railway capital on June 30, 1896, was $10,506,865,771, or $59,610 per mile of line. These figures do not include current liabilities, which, if included as a part of capital, as in former years, would increase the amount of outstanding capital about $613,000,000, making the amount per mile of line $63,068. The amount of capital stock was $5,226,527,269, and the funded debt was $5,340,338,502. The amount of stock paying no dividend was 70.17% of the total. The amount of funded debt, not including equipment trust obligations, which paid no interest, was $860,559,442. Of the stock paying dividends, 1.68% of the total paid from 3 to 4%; 5.55% paid from 4 to 5%; 6.82% paid from 5 to 6%; 3.91% paid from 6 to 7%, and 4.37% paid from 7 to 8%. The total amount of dividends was $87,603,371, or 5.62% on the amount of stock on which some dividend was declared. The amount of bonds paying no interest was 11.40%; of miscellaneous obligations, 15.05%, and of income bonds, 87.96%.

Public Service.—The number of passengers carried during the year ending June 30, 1896, was 511,772,737, being an increase of 4,351,375 as compared with the year ending June 30, 1895. The number of passengers carried one mile per mile of line—that is, the figures indicating the density of passenger traffic during the year ending June 30, 1896—was 71,705, an increase of 3,133 in this item being shown. The number of tons of freight carried was 765,801,385. This is the largest tonnage ever reported for railways in the United States. The increase during the year was 69,130,214. The density of freight

WEATHER TABLE FOR SEPTEMBER, 1897. (Furnished to Engineering News by the Department of Agriculture.)

	Stations	Temperature. (Degrees Fahrenheit.)				Wind.			Precipitation—rain or melted snow—inches.		
						Velocity in miles per hour.		Direction at time of max. velocity.			
		Average.	Max.	Min.	Range.	Average	Max.		Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	54.9	90	28	62	7.4	36	NW	1.43	0 58	8
	Portland, Me.	59.0	94	39	55	6.6	30	S	2.34	1.17	9
	New York City	65.4	91	44	47	12.5	42	NW	1.64	0.98	6
	Pittsburg, Pa.	67.6	96	38	58	3.7	24	NW	1.65	0.52	7
	Chicago, Ill.	69.5	94	42	52	15.7	39	NE	0.84	0.43	2
	Omaha, Neb.	75.2	99	45	54	7.2	29	NW	1.39	1.17	4
	St. Paul, Minn.	67.6	90	38	52	6.8	32	NW	1.33	0.49	8
	Duluth, Minn.	62.6	89	39	50	10.0	35	NW	3.14	1.99	6
	Bismarck, N. Dak.	67.1	102	32	70	9.2	34	S	0.30	0.10	4
	Average.	65.4	94	38	56	8.8	33		1.56	0.82	6
Southern Cities.	Washington, D. C.	68.2	97	42	55	5.4	28	NW	1.54	1.28	3
	Louisville, Ky.	74.5	100	42	58	6.1	33	SW	0.75	0.75	2
	St Louis, Mo.	77.4	98	45	53	7.3	34	NW	0.09	0.09	1
	Savannah, Ga.	74.2	92	46	46	9.2	40	N	6.52	2.88	11
	Kansas City, Mo.	76.8	99	47	52	6 4	24	S	1.38	1.06	3
	Jacksonville, Fla.	76.3	94	49	45	8.2	36	NE	16.23	5.35	17
	Chattanooga, Tenn.	74.4	96	46	50	5.3	28	SE	0 07	0.06	2
	New Orleans, La.	79.4	94	62	32	10.0	42	NE	3.19	2.31	8
	Memphis, Tenn.	78.0	96	49	47	8.0	25	N	0	0	0
	Palestine, Tex.	77.8	100	49	51	5.9	26	NE	1.36	0.70	5
	Average.	75.7	97	48	49	7.2	32		3.11	1.45	5
Western Cities.	Helena, Mont.	57.8	81	30	51	6.2	36	SW	0 66	0.43	7
	Port Angeles, Wash.	52.8	75	36	39	4.6	20	W	1.32	0.67	8
	San Francisco, Cal.	60 8	92	50	42	11.8	37	W	0.10	0.08	2
	Salt Lake City, Utah.	66.3	88	43	45	6.4	30	SW	0 48	0 34	5
	Santa Fe, N. Mex.	61.9	81	43	38	4 9	27	E	2.49	0.88	15
	Denver, Colo.	66.4	93	40	53	6.8	33	NW	0 44	0.37	3
	Yuma, Ariz	85.4	105	62	43	—	28	SE	0.20	0.11	4
	Average.	64.5	88	43	44	—	30		0.81	0.41	6

traffic is shown by the number of tons of freight carried one mile per mile of line, which was 523,832. These figures, as compared with those of the preceding year, show an increase of 44,342 ton-miles per mile of line.

Earnings and Expenses.—The gross earnings of the railways of the United States for the year ending June 30, 1896, were $1,150,160,376, having increased in comparison with the previous year $74,797,914. The expenses of operation for the year covered by the report were $772,989,044, being greater by $47,268,629 than the preceding year.

The income from operation, that is, the amount of gross earnings remaining after the deduction of operating expenses, was $377,180,332, which exceeds the corresponding item for 1895 by $27,529,285. The income from other sources, mainly from leases and investments, was $129,024,731, which, added to the income from operation, makes a total income of $506,205,063. The total deductions from income were $416,573,137, so that the net income out of which dividends and surplus were declared was $89,631,926. This small amount of surplus, however, shows an improvement, since the results of railway operations during the years 1895 and 1894, showed deficits of $29,845,241, and $45,851,294, respectively.

Railway Accidents.—The statistics submitted show that the number of railway employees killed during the year ending June 30, 1896, was 1,861, and the number injured was 29,969. These figures indicate an increase of 50 in the number killed, and of 4,273 in the number injured, as compared with the preceding year. The number of passengers killed was 181, and the number of passengers injured 2,873, being an increase of 11 in the number killed and of 498 in the number injured. The number of persons other than employees and passengers killed was 4,406 and the number injured 5,845. These figures include casualties to persons reported as trespassers, of whom 3,811 were killed and 4,468 were injured. From summaries showing the ratio of casualties it is found that for every 444 men employed on railways 1 was killed, and for every 28 men employed 1 was injured. A similar comparison as to trainmen shows that 1 trainman was killed for each 152 trainmen employed, and that 1 trainman was injured for each 10 trainmen employed. The number of passengers carried for 1 passenger killed was 2,827,474, and the number of passengers carried for 1 passenger injured was 178,132. As showing in another way the immunity of passengers from accidents, the report gives ratios based upon the number of miles traveled, from which it appears that 72,093,983 passenger-miles were accomplished for every passenger killed, and 4,541,945 passenger-miles for every passenger injured.

In conclusion the Statistician urges that reports should be secured from express companies; from corporations owning rolling stock which is used in interstate traffic; from corporations owning depot property, elevators, etc., and from carriers by water so far as their business is interstate.

BOOK REVIEWS.

MAINTENANCE OF WAY STANDARDS ON AMERICAN RAILWAYS, and Rules and Instructions Governing Roadway Departments.—Compiled by F. A. Smith, C. E., Editor of "The Roadmaster and Foreman." Chicago: Roadmaster and Foreman. Cloth; 7¾ × 5½ ins.; pp. 557; illustrated. Price, $1.50.

This is not a treatise upon or discussion of track or track work, but a compilation of the rules and regulations issued by 13 railways to their roadway departments, and illustrated by reproductions of the drawings of standard track materials and appliances of these and a few other roads. The plates are numbered in Arabic numerals, which is not to be commended, especially when the numbering reaches up to CLXIV., etc., as in this book. The rules are not given in full for each road, but extracts are made dealing with different parts of the work. Of course, with a book made up in this way, there can be no discussion of the subjects included, and no information as to the merits or defects of various appliances and rules, and in case of apparently conflicting rules the reader is of necessity left to take his choice as to which is the better or the more correct. The railways are all important trunk lines, and include 7 Eastern roads, 3 Southern roads and 3 Western roads, with drawings of some standards of 6 miscellaneous roads. The book is a useful one for officers and employees of the roadway department, especially on those numerous roads which have as yet no regular rules for the instruction of the trackmen. The compiler states that his aim has been to prepare the way for a uniform official code of maintenance of way standards and rules.

LECTURES ON EXPLOSIVES.—A course of Lectures prepared especially as a manual and guide in the laboratory of the U. S. Artillery School. By Willoughby Walke, First Lieutenant, 5th U. S. Artilery, Instructor. Second edition, revised and enlarged. New York, 1897: John Wiley & Sons. Cloth; 6 × 9¼ ins.; pp. 435; $4.00.

This work is a general treatise upon explosives of all types, with a statement of their composition, chemical theory, effectiveness, application and treatment for military purposes. One of the early chapters is devoted to a description of all the ingredients entering into the composition of explosives and the substances used in their preparation. The manufacture of gunpowder; its classification into many special forms, as resulting from different treatments; the methods of testing gunpowders and the chemical theory of its combustion, are exhaustively treated. Under the general head of high explosives is found an almost bewildering variety of compounds, subdivided as explosive mixtures of the chlorate class, nitro-substitution class, nitric derivative class, gun cotton, nitric ethers or nitroglycerine, dynamite, smokeless powders, and explosives of the Sprengel class. Closing chapters treat of fulminates, the manipulation, storage and transport of high explosives, their application for military purposes and use in shells. The author has so treated his work that it is not only a valuable book of reference in all matters relating to explosives, but it is also interesting reading, to the engineer, at least.

INFORMATION RESPECTING THE YUKON DISTRICT.—From the Reports of Wm. Ogilvie, Dominion Land Surveyor, and from Other Sources. Pub. Doc., Department of the Interior, Ottawa, Canada. Paper, 8vo.; pp. 65; maps, 5; half-tone plates, 10.

This report has just been issued in consequence of the great tide of emigration to the Klondyke gold mining region on the Yukon River, Alaska, but an introductory note warns persons against going to that remote country until better means of communication are established. Mr. Ogilvie's report of his exploration made in 1887, and extracts from his official letters during 1895 and up to Jan. 23, 1897, occupy about 54 pages, and make most interesting reading, the report itself drawing the attention of the reader as does a boy's book of adventure. The expedition was for the survey of the 141st meridian, forming the boundary between American and British Territory, and Mr. Ogilvie went up the Chilkoot Inlet and Taiya Inlet, and across to Lake Lindeman, encountering considerable trouble from the avarice and indolence of the Indians. The Taiya Pass is said to be impracticable for a road or railway, but Mr. Ogilvie discovered a lower and more practicable pass, which he named the White Pass, leading northeast to the Tagish Lake. The party made its way from Lake Lindeman through adjacent lakes and down Miles Canyon (in which are several rapids) to Lake Labarge and the Lewes River, which latter river and the Pelly River unite at Fort Selkirk to form the Yukon River. The difficulties and characteristics of the route are described in detail, with much interesting professional information as to the work of the survey, the development of the mineral resources and the peculiarities of the Indians. The agricutural capacity of the country is not great enough to attract much attention, and while there a large extent of forest which would yield firewood and timber for mining work, there is little timber suitable for lumber. Coal and small quantities of gold-quartz were found, but Mr. Ogilvie predicted that rich finds of this quartz would be discovered, although most of the gold now being taken out is obtained from the gravel deposits by the simple process of washing. Asbestos has also been found. The animals in the district include caribou, moose, bears, mountain sheep and goats, and a few wolves and arctic rabbits, but a boom in mining would soon lead to the extermination of the game along the river. The word "Klondak" is, he says, a mispronunciation of the Indian word "Thron-dak," meaning "plenty of fish," this being a famous salmon stream. The statements of the richness of the gold deposits and the amount of gold obtained by crude appliances in a short time are calculated to make one's mouth water, in spite of the records of the difficulties and dangers of getting into the district. The climate is wet, with heavy rainfall, and even with the continuous summer sun evaporation is slow, owing to the thick moss on the ground. During the winter the cold is intense, with considerable wind, while the cold and damp along the river cause rheumatic and lung troubles. The book includes a table of distances, a historical sketch, notes on means of access, and extracts from the reports of Inspector Constantine and Assistant Surgeon Wells (of the Northwest Mounted Police).

TWENTY-FIRST YEAR-BOOK OF THE NEW YORK STATE REFORMATORY, for the fiscal year ending Sept. 30, 1896.—Z. R. Brockway, General Superintendent, Elmira, N. Y. Cloth; 8½ × 6 ins.; pp. 131, with illustrations and anthropometric tables.

While not in the line of technical literature usually reviewed by this journal, this publication is of such interest to every student of social problems that we believe it well worth notice here. The Elmira Reformatory has become famous as one of the most promising attempts ever made to reform instead of merely punish those convicted of minor crimes. This reformatory was founded by the state of New York about 20 years ago for the detention of prisoners convicted of a first crime, but, as a matter of fact, fully 40% of those now in the Elmira Reformatory have had a previous experience of arrest or confinement in institutions or prisons. The average age of the 1,400 prisoners is about 21 years. Under the system of treatment now in use there prisoners are divided into grades according to their character and intellectual ability. They are also grouped in classes for instruction in trades and for military drill. The general classes are again subdivided and the whole classification will ultimately constitute a manual training class, whose exercises will occupy the time of every day which is not devoted to the more general reformation department. Schools are established for education and trades instruction is given in many branches. In the latter connection it is stated that of the 1,400 odd men now confined, less than 2% had trades on their admission, and these were among the least remunerative trades. The Reformatory gives good instruction in 34 different trades, covering the six mechanical groups of wood working and finishing, metal working, construction and fitting, domestic, decorative and liberal, typographical and bookbinding. Of the 329 men paroled in the last year, 324 obtained work at trades acquired at the institution.

A manual training experiment class of 141 men was established at the beginning of the last year, and these men were selected from all the groups and subdivisions for the completest possible adaptation of exercises to the end in view, which was mathematical quickening, self-control and general mental quickening. These men were divided into three special groups and the course of study for each group was as follows: 1. Athletics and calisthenics, cardboard construction, free hand and mechanical drawing, mental arithmetic and wood turning. 2. Athletics and calisthenics, advanced cardboard construction, clay modeling, drawing, advanced mental arithmetic, modeling, turning and pattern making, vise work. 3. Athletics and calesthenics, simple cardboard construction, clay modeling, free hand drawing, wood carving and wood turning. The teaching force was composed of three civil instructors and 20 trained inmate instructors, and the course of study for each group covered one year. As a general result of this system of building up defective faculties, out of the 141 men 28 showed decided improvement during the year; 17 showed some improvement; 6 made partial improvement in school work, but not in trades; 13 were withdrawn for invalidism, incorrigibility, etc.; 36 were still irresponsive, and 39 were too recently assigned to warrant expectation of improvement at time of report. The system was extended to a class of 500 pupils in 1897, and the progress will be closely watched. The report fully describes the athletic exercises, which form an important part of the manual training system.

RAILWAY TRACK AND TRACK WORK.—By E. E. Russell Tratman, A. M. Am. Soc. C. E., Associate Editor of Engineering News. New York: The Engineering News Publishing Co. 8vo.; cloth; pp. 418; illustrations, 227; tables, 40. Price, $3.

Our established rule in reviewing our own publications is to do little more than quote the preface to the work, but it may be well for the information of our readers to call attention briefly to the very wide scope of this book.

Part 1, on "Track," opens with a discussion on the relation of track to the traffic which it carries, and then takes up in detail not only the roadbed construction and the ordinary track material (rails, wooden and steel ties, rail joints and fastenings, switches and frogs, fences, cattle guards, track tools, etc.), but also deals with such allied subjects as bridge floors, coal and water stations, turntables, mail cranes, section houses, track signs, the protection of grade crossings, and the design and operation of yards.

Part 2, on "Track Work," deals in detail with the regular and varied work of maintenance, and includes also bridge, switch, curve and telegraph work, the clearing of snow and wrecks, while it also includes double tracking, filling trestles, and other general improvements. The systems of organization of the maintenance of way departments are discussed, the duties of the roadmasters and other track officials are reviewed, and numerous examples are given of the forms of reports used in track work. Two folding tables give the details of the standard track construction of 52 railways.

Having thus explained the scope of the work we give an abstract of the author's preface:

In view of the importance of the railway track which carries the enormous railway traffic of the United States, and in view of the amount of engineering and technical work involved in the construction and maintenance of the track, it may appear somewhat strange that the technical literature on the subject should be so limited. The first practical and comprehensive book on track and maintenance work as a whole was "The Roadmasters' and Section Masters' Guide," written in 1871 by Mr. W. S. Huntington, and revised and enlarged some years afterward by the late Mr. Charles Latimer. This was followed in 1886 by "Track," written by Mr. W. B. Parsons, and this book had a very extensive sale, but has now been out of print for some years. This book is familiar to every engineer on railway work, but its scope was somewhat limited, and in many respects it is now behind the times. Probably the only other comprehensive work on the subject is "The Trackman's Helper," written by Mr. J. Kindelan, being a practical book intended specially for the use of section foremen. It is true that there is a fairly extensive, but scattered, literature consisting of books and pamphlets on various individual details of track and track work, but the majority of these have only a limited circulation, while the men who have collected a number of such works have rarely the time or opportunity to study and digest them.

For these reasons and from the fact that inquiries are being continually made for a modern comprehensive book on track work, it appears that there is a large field open for the introduction of a work of this character, and it is to meet this demand that the present book on "Track and Track Work" has been prepared. The aim of the writer (who is the author of other works connected with railway track and its improvement) has been to treat the subject as comprehensively as possible. The book, therefore, includes not only the systems which are everywhere applicable, and the general principles underlying track work, but also includes the numerous details of material, appliances, and work, and the various methods of practice, which vary on different roads and in different sections of the country. It is thus fully representative of modern practice and standards on railways in all parts of the country. The various subjects included are treated not merely in a descriptive but also in a critical manner, with remarks upon the advantages and disadvantages of individual appliances and methods of work.